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

FIRST SEMESTER SYLLABUS

Bachelor of Science (B.Sc.) in Physics — Semester I

(NEP 2020 Aligned | Industry & Research Integrated)

Admission Batch 2026-27

Semester	I (First Semester)
Total Credits	20 Credits
Total Contact Hours / Week	22 Hours
Number of Courses	7 (4 Theory, 1 Practical, 1 Multi-Disciplinary, 1 AEC/VAC/SEC each)

Semester I — Course Basket

Sl.	Type of Course	Code	Subject Name	L-T-P-S	Hrs	Cr.
1	DSC (Theory)	BSPH101	Mathematical Physics-I	3-1-0-0	4	4
2	DSC (Theory)	BSPH102	Mechanics & Properties of Matter	3-1-0-0	4	4
3	DSC (Practical)	BSPH191	Physics Laboratory-I	0-0-4-0	4	2
4	Multi-Disciplinary	BSMA103	Mathematics for Physicists-I	3-1-0-0	4	4
5	AEC	AEC101	Communication Skills	2-0-0-0	2	2
6	VAC	VAC101	Environmental Science	2-0-0-0	2	2
7	SEC	SEC101	Yoga & Wellness	0-0-0-2	2	2
			Total		**22**	**20**

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1. Mathematical Physics-I (BSPH101)

Subject Name	Mathematical Physics-I	**Credit**	4
Subject Code	BSPH101	**Lecture Hours**	48

Pre-requisite: 10+2 level Mathematics (Algebra, Trigonometry, elementary Calculus)

Relevant Links: NPTEL: Mathematical Methods in Physics-I; NPTEL: Mathematical Physics-I (IIT Guwahati); MIT OCW: Single Variable Calculus

Course Objectives

1. To develop proficiency in vector algebra and vector calculus as tools for describing physical laws.
2. To build a working command of differential and integral calculus of one and several variables for physics problems.
3. To introduce ordinary differential equations that recur in mechanics, electricity and waves.
4. To familiarise students with multiple integrals and their use in computing physical quantities such as mass, area and volume.

Course Outcomes

- CO1: Apply vector algebra and vector calculus (gradient, divergence, curl) to represent physical fields and forces.
- CO2: Differentiate and integrate functions of one and several variables and apply partial differentiation to physics problems.
- CO3: Formulate and solve first- and second-order ordinary differential equations arising in physical systems.
- CO4: Evaluate double and triple integrals and apply them to compute area, volume and centre of mass.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Vector Algebra & Vector Calculus	Scalars and vectors, vector addition/subtraction, scalar and vector products, triple products; vector differentiation, gradient, divergence and curl; line, surface and volume integrals; Gauss and Stokes theorems (statement and simple applications)	MIT OCW Classical Mechanics (vector review); MATLAB/Mathematica for vector field visualisation	T1 Ch.1-2	10	Plotting scalar and vector fields and their gradient/divergence/curl using Python/MATLAB
2	Differential Calculus	Functions, limits and continuity; successive differentiation, Leibnitz theorem; Rolle's theorem, Mean Value theorems, Taylor's and Maclaurin's series with remainder; partial differentiation, Euler's theorem on homogeneous functions, total derivatives, Jacobians	MIT OCW Single Variable Calculus; Wolfram Mathematica / MATLAB Symbolic Toolbox	T1 Ch.3-4	10	Series expansion and error-estimation exercises using Python (SymPy)
3	Integral Calculus	Methods of integration, reduction formulae, improper integrals; Beta and Gamma functions and their properties; applications of definite integrals: area, arc length, volume and surface of revolution	MIT OCW Single Variable Calculus (integration); MATLAB numerical integration toolbox	T1 Ch.5	8	Numerical evaluation of definite/improper integrals in Python (SciPy)
4	Ordinary Differential Equations	First-order first-degree equations: exact equations, integrating factors, linear and Bernoulli equations; linear second-order differential equations with constant coefficients; D-operator method; simple harmonic and damped oscillator equations as physical applications	MIT OCW Calculus Revisited: Differential Equations & Linear Algebra; MATLAB/Simulink ODE solvers	T1 Ch.6	10	Solving and plotting solutions of first- and second-order ODEs numerically (Python odeint)

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
5	Multiple Integrals	Double integrals in Cartesian and polar form, change of order of integration; triple integrals in Cartesian, cylindrical and spherical coordinates; applications: centre of mass, moment of inertia of simple bodies	MIT OCW Multivariable Calculus; MATLAB/Mathematica multiple-integration routines	T2 Ch.7	10	Computing moment of inertia of standard bodies via multiple integration in Python

Text Books

- T1: B. S. Grewal, "Higher Engineering Mathematics", 44th Edition (2021), Khanna Publishers.
- T2: Mary L. Boas, "Mathematical Methods in the Physical Sciences", 3rd Edition, Wiley.

Reference Books

- G. B. Arfken, H. J. Weber & F. E. Harris, "Mathematical Methods for Physicists", 7th Edition, Academic Press.
- P. Dennery & A. Krzywicki, "Mathematics for Physicists", Dover Publications.
- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons.

2. Mechanics & Properties of Matter (BSPH102)

Subject Name	Mechanics & Properties of Matter	**Credit**	4
Subject Code	BSPH102	**Lecture Hours**	48

Pre-requisite: 10+2 level Physics and Mathematics

Relevant Links: MIT OCW: Classical Mechanics (8.01SC); NPTEL: Classical Mechanics — Newtonian to Lagrangian (IIT Kharagpur); NPTEL: Introduction to Classical Mechanics (IIT Hyderabad)

Course Objectives

1. To build a rigorous foundation in Newtonian mechanics of particles and rigid bodies.
2. To introduce rotational dynamics, gravitation and oscillatory motion.
3. To develop an understanding of elastic properties of matter and their engineering relevance.
4. To introduce the mechanics of fluids at rest and in motion.

Course Outcomes

- CO1: Apply Newton's laws and conservation principles to solve problems of particle and system dynamics.
- CO2: Analyse rotational motion, torque and angular momentum for rigid bodies, and apply Kepler's laws to orbital motion.
- CO3: Solve for the response of free, damped and forced (simple harmonic) oscillators.
- CO4: Characterise elastic behaviour of solids and the flow behaviour of viscous fluids.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Newtonian Mechanics	Newton's laws, inertial and non-inertial frames, pseudo-forces; conservation of linear momentum, work-energy theorem, conservation of energy; motion under central forces, collisions (elastic and inelastic)	MIT OCW 8.01SC Classical Mechanics; MATLAB/Python rigid-body simulators	T1 Ch.1-3	8	Verification of conservation of momentum using an air-track/collision simulator
2	Rotational Dynamics & Gravitation	Angular momentum, torque, moment of inertia, theorems of parallel and perpendicular axes; rigid-body rotation about a fixed axis, rolling motion; Newton's law of gravitation, Kepler's laws, motion of planets and satellites	NPTEL Classical Mechanics: Newtonian to Lagrangian; Satellite-orbit simulation software (STK, GMAT)	T1 Ch.4-5	10	Determination of moment of inertia of a flywheel
3	Oscillations	Simple harmonic motion, energy of SHM, differential equation of SHM; damped oscillations, forced oscillations and resonance, quality factor; coupled oscillators (introductory treatment)	MIT OCW 8.03 Vibrations and Waves; MATLAB/Simulink oscillator models	T1 Ch.6	8	Determination of g using a compound (bar) pendulum
4	Elasticity	Stress, strain, Hooke's law, elastic moduli (Young's, bulk, rigidity); bending of beams, torsion of a cylinder, elastic energy; Poisson's ratio and relations between elastic constants	NPTEL Mechanics of Solids; ANSYS / material-testing instrumentation	T2 Ch.3	10	Determination of Young's modulus by uniform bending

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
5	Fluid Mechanics	Viscosity of liquids, Poiseuille's and Stokes' laws, terminal velocity; surface tension, capillary rise, excess pressure across a curved surface; streamline and turbulent flow, Reynolds number, Bernoulli's theorem	MIT OCW 8.01SC Fluid Mechanics module; CFD software (ANSYS Fluent, OpenFOAM)	T2 Ch.4	12	Determination of coefficient of viscosity by Stokes' method; determination of surface tension by capillary rise method

Text Books

- T1: D. S. Mathur, "Mechanics", S. Chand Publishing.
- T2: D. S. Mathur, "Properties of Matter", S. Chand Publishing.

Reference Books

- H. Goldstein, C. Poole & J. Safko, "Classical Mechanics", 3rd Edition, Pearson.
- J. C. Upadhyaya, "Mechanics, Waves and Thermodynamics", Himalaya Publishing House.
- R. Resnick, D. Halliday & K. Krane, "Physics", Vol. 1, Wiley.

3. Physics Laboratory-I (BSPH191)

Subject Name	Physics Laboratory-I	**Credit**	2
Subject Code	BSPH191	**Lecture Hours**	0

Pre-requisite: Concurrent with BSPH101/BSPH102; basic knowledge of Vernier calipers and screw gauge

Relevant Links: Amrita Virtual Physics Laboratory; AMV Advanced Mechanics Virtual Lab; Amrita Mechanics Virtual Lab

Course Objectives

1. To develop skill in the use of precision measuring instruments such as the Vernier caliper and screw gauge.
2. To verify, through experiment, the mechanical principles covered in BSPH102.
3. To train students in recording, tabulating, graphing and error-analysing experimental data.

Course Outcomes

- CO1: Use Vernier calipers and screw gauges to measure length, diameter and thickness with correct error estimation.
- CO2: Determine mechanical quantities (g, moment of inertia, elastic moduli) by direct experiment.
- CO3: Determine surface tension and viscosity of liquids and relate results to theory.
- CO4: Prepare a laboratory report with data tables, graphs, error analysis and conclusions.

List of Experiments

- Use of Vernier caliper and screw gauge to measure dimensions of regular solids
- Determination of g using a compound (bar) pendulum
- Determination of moment of inertia of a flywheel
- Determination of Young's modulus of a beam by uniform/non-uniform bending
- Determination of surface tension of a liquid by capillary-rise method
- Determination of coefficient of viscosity of a liquid by Stokes' method

Each experiment is performed with a hands-on apparatus session followed by a virtual-lab verification (Amrita Virtual Lab — Physical Sciences). Total: 60 contact hours.

Text Books

- Department of Physics, UEM Jaipur — B.Sc. Physics Laboratory Manual, Semester I.
- S. L. Gupta & V. Kumar, "Practical Physics", Pragati Prakashan.

Reference Books

- B. L. Worsnop & H. T. Flint, "Advanced Practical Physics for Students", CBS Publishers.

4. Mathematics for Physicists-I (Calculus & Linear Algebra) (BSMA103)

Subject Name	Mathematics for Physicists-I (Calculus & Linear Algebra)	**Credit**	4
Subject Code	BSMA103	**Lecture Hours**	48

Pre-requisite: 10+2 level Mathematics

Relevant Links: MIT OCW: Linear Algebra (18.06SC); NPTEL: Linear Algebra (IIT Madras); MIT OCW: Single Variable Calculus

Course Objectives

1. To consolidate calculus of a single variable and extend it to functions of several variables.
2. To develop the algebra of vector spaces, matrices and linear transformations.
3. To introduce eigenvalues, eigenvectors and diagonalisation as tools used throughout physics.
4. To connect calculus and linear-algebra concepts to problems the student will meet in Mechanics and Electromagnetism.

Course Outcomes

- CO1: Differentiate and integrate functions of one variable and apply Taylor/Maclaurin expansions.
- CO2: Perform matrix operations, determine rank and solve systems of linear equations.
- CO3: Compute eigenvalues and eigenvectors and diagonalise matrices of small dimension.
- CO4: Apply vector-space concepts (basis, dimension, linear independence) to physical problems.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Calculus of a Single Variable	Limits, continuity, differentiability; standard differentiation techniques; applications: maxima/minima, curve sketching, related rates; Riemann integration, fundamental theorem of calculus, techniques of integration	MIT OCW 18.01SC Single Variable Calculus; MATLAB/Wolfram Alpha for symbolic calculus	T1 Ch.1-3	10	Plotting functions and their derivatives/integrals using Python (Matplotlib, SymPy)
2	Vector Spaces and Matrices	Vector spaces, subspaces, linear independence, basis and dimension; matrix algebra, rank of a matrix, solving linear systems (Gauss elimination); special matrices: symmetric, orthogonal, Hermitian	MIT OCW 18.06SC Linear Algebra; MATLAB/NumPy linear-algebra libraries	T2 Ch.15	12	Solving linear systems and computing matrix rank using NumPy
3	Eigenvalues, Eigenvectors and Diagonalisation	Characteristic equation, eigenvalues and eigenvectors, Cayley-Hamilton theorem; diagonalisation of matrices, similarity transformations; application to coupled oscillators and normal modes (introductory)	NPTEL Linear Algebra, IIT Madras; MATLAB eig() routines used in structural/vibration analysis	T2 Ch.15	10	Computing eigenvalues/eigenvectors of physically-motivated matrices in Python
4	Multivariable Calculus	Functions of several variables, partial derivatives, total differential; maxima, minima and saddle points; Lagrange multipliers; double integrals and simple applications to area/mass	MIT OCW 18.02SC Multivariable Calculus; MATLAB/Mathematica optimisation toolboxes	T1 Ch.5	8	Locating extrema of two-variable functions numerically in Python
5	Inner Product Spaces	Inner product, norm, orthogonality, Gram-Schmidt orthogonalisation; orthonormal bases and their use in representing physical states/signals	MIT OCW 18.06SC Linear Algebra — Orthogonality; Signal-processing libraries (SciPy)	T2 Ch.27	8	Gram-Schmidt orthogonalisation of vectors in R^3 using Python

Text Books

- T1: B. S. Grewal, "Higher Engineering Mathematics", 44th Edition (2021), Khanna Publishers.

- T2: B. K. Pal & K. Das, "Engineering Mathematics", Vol. 1, 10th Edition (2021), U. N. Dhur & Sons.

Reference Books

- Gilbert Strang, "Introduction to Linear Algebra", 5th Edition, Wellesley-Cambridge Press.
- Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, John Wiley & Sons.

5. Communication Skills (AEC101)

Subject Name	Communication Skills	**Credit**	2
Subject Code	AEC101	**Lecture Hours**	24

Pre-requisite: Basic English proficiency (10+2 level)

Relevant Links: NPTEL: Communication Skills (IIT Kanpur); NPTEL: Technical English for Engineers (IIT Madras)

Course Objectives

1. To strengthen listening, speaking, reading and writing skills for academic and professional contexts.
2. To develop skills in technical and scientific writing relevant to a Physics undergraduate.
3. To build confidence in oral presentation, group discussion and interview skills.

Course Outcomes

- CO1: Communicate effectively in spoken and written English in academic and workplace settings.
- CO2: Write structured technical reports, lab reports and scientific summaries.
- CO3: Participate effectively in discussions, presentations and interviews.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Foundations of Communication	Barriers to communication, verbal and non-verbal communication; listening skills and comprehension strategies	Workplace and viva communication	Unit 1	6	Listening comprehension and role-play exercises
2	Written Communication & Scientific Reporting	Paragraph and essay writing, technical/lab report writing; letter and e-mail writing, CV/resume preparation	Report writing for internships/projects	Unit 2	8	Drafting a laboratory/technical report
3	Oral Communication	Public speaking and presentation skills; group discussion and interview techniques	Placement interview preparation	Unit 3	10	Mock presentations and group discussions

Text Books

- Meenakshi Raman & Sangeeta Sharma, "Technical Communication: Principles and Practice", Oxford University Press.

Reference Books

- Sanjay Kumar & Pushp Lata, "Communication Skills", Oxford University Press.

6. Environmental Science (VAC101)

Subject Name	Environmental Science	**Credit**	2
Subject Code	VAC101	**Lecture Hours**	24

Pre-requisite: 10+2 level Science

Relevant Links: NPTEL: Environmental Science

Course Objectives

1. To introduce the multidisciplinary nature of the environment and natural resources.
2. To create awareness of ecosystems, biodiversity and environmental pollution.
3. To sensitise students to sustainable development and environmental policy.

Course Outcomes

- CO1: Explain the structure and function of ecosystems and the concept of biodiversity.
- CO2: Identify major sources and effects of air, water and soil pollution.
- CO3: Discuss principles of sustainable development and relevant environmental legislation.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Natural Resources and Ecosystems	Renewable and non-renewable resources; structure and function of ecosystems; biodiversity and its conservation	Environmental impact assessment practice	Unit 1	8	—
2	Environmental Pollution	Air, water and soil pollution: causes and control; solid waste management; climate change: causes and mitigation	Pollution-control board case studies	Unit 2	8	—
3	Sustainable Development & Policy	Sustainable development goals; Environmental Protection Act and related legislation in India; role of technology in environmental management	ISO 14000 / EIA practice	Unit 3	8	—

Text Books

- Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", Universities Press.

Reference Books

- G. Tyler Miller, "Environmental Science", Cengage Learning.

7. Yoga & Wellness (SEC101)

Subject Name	Yoga & Wellness	**Credit**	2
Subject Code	SEC101	**Lecture Hours**	24

Pre-requisite: None

Relevant Links: NPTEL: Yoga & Positive Psychology for Managing Career and Life (IIT Bombay); NPTEL: Stress Management (IIT Kharagpur)

Course Objectives

1. To introduce the philosophy and practice of Yoga for physical and mental well-being.
2. To build practical skills in stress-management and mindfulness relevant to student life.
3. To promote healthy lifestyle habits that support academic performance.

Course Outcomes

- CO1: Practice basic asanas, pranayama and meditation techniques safely.
- CO2: Apply stress-management techniques to academic and personal life.
- CO3: Explain the link between physical wellness, mental health and productivity.

Detailed Syllabus

Module	Topic	Sub-topics	Industry / Academia Mapping	Text	Hrs	Lab Assignment
1	Foundations of Yoga	History and philosophy of Yoga; asanas and pranayama — theory and safe practice	Corporate wellness programmes	Unit 1	8	Guided asana and pranayama practice sessions
2	Stress & Mind Management	Physiology of stress; mindfulness and meditation techniques	Workplace stress-management training	Unit 2	8	Guided meditation and relaxation sessions
3	Wellness and Lifestyle	Diet, sleep and exercise for student well-being; building resilience and positive habits	Positive psychology practice	Unit 3	8	Personal wellness plan preparation

Text Books

- Swami Kuvalayananda, "Asanas", Kaivalyadhama.

Reference Books

- B.K.S. Iyengar, "Light on Yoga", HarperCollins.