

CHOICE BASED CREDITSYSTEM

B. SC. PHYSICS (Honours Course) Syllabus (Reduced Syllabus for the Session 2020-21)



**Department of Physics
Bodoland University
BTAD, Kokrajhar-783370
Assam.**

Department of Physics
Bodoland University
Curriculum Structures for UG syllabus (B.Sc. Honours)
No. of papers =14+12=26, Total Credits= 140
Total Marks = 2400

SEM-I						
Paper Code	Course	Credit	Credit Distribution (L+T+P)	End Sem Marks	Internal Marks	Total Marks
PHY-101H	C-1: Mathematica Phyiscs-I	6	4+0+2	60(Theo)+20(Pract)	20	100
PHY-102H	C-2: Mechanics	6	4+0+2	60(Theo)+20(Pract)	20	100
PHY-101R	GE-1: Mechanics	6	4+0+2	60(Theo)+20(Pract)	20	100
COMM-104HR	AECC-1: English/Hind/MIL (Communication)	2	2+0+0	50	-	50
Total		20	20	290	60	350

B. Sc. Physics (Honours course) syllabus under CBCS

Sem ester	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2)	Discipline Specific Elective (DSE) (4)	Generic Elective (GE) (4)
I	<i>C1: Mathematical Physics-I (4+2)</i> <i>C2: Mechanics (4+2)</i>	(English/Hindi/MIL Communication)			GE-1

Note: Physics student must opt at least two generic elective papers from mathematics to pursue M.Sc.in physics.

List of Physics generic elective for other discipline:

GE-1: Mechanics (4) + Lab (2)

GE-2: Electricity, Magnetism and EMT (4) + Lab (2)

GE-3: Thermal Physics and Statistical Mechanics (4) + Lab (2)

GE-4: Waves and Optics (4) + Lab (2)

List of Discipline specific elective(DSE):

DSE-1: Advanced Mathematical Physics-I (4+2)

DSE-2: Nuclear and Particle Physics(5+1)

DSE-3: Classical Dynamics (5+1)

DSE-4: Experimental Techniques (4+2) *or* Dissertation (6)

List of Skill Enhancement Course

(SEC):SEC -1: Physics Workshop Skill

(2) SEC-2: Computational Physics Skill

Semester I

PHYSICS-C 1: MATHEMATICAL PHYSICS-I

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Approximation: Taylor and binomial series (statements only).
(2 Lectures)

First Order and Second Order Differential Equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution.
(13 Lectures)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration.
(6 Lectures)

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively.
(5 Lectures)

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. ∇ and Laplacian operators.
(8 Lectures)

Vector Integration: Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).
(14 Lectures)

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(6 Lectures)**

Introduction to probability:

Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance.

(4 Lectures)**Dirac Delta function and its properties:**

Definition of Dirac delta function. Properties of Dirac delta function.

(2 Lectures)**Reference Books:**

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
 - An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI Learning
 - Differential Equations, George F. Simmons, 2007, McGraw Hill.
 - Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
 - Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
 - Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5th Ed., 2012, Jones and Bartlett Learning
 - Mathematical Physics, Goswami, 1st edition, Cengage Learning
 - Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press
 - Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
 - Essential Mathematical Methods, K.F. Riley & M.P. Hobson, 2011, Cambridge Univ. Press
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PHYSICS - C 1 LAB:**60 Lectures**

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation is done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use anyone operating system Linux or Microsoft Windows*

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices

Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow - emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, cin and cout, Manipulators for data formatting, Control statements (decision making and looping statements) (<i>If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops</i>), Arrays (<i>1D & 2D</i>) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending/descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi (π)
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $(\sin \alpha)^2$ in optics $\alpha = \tan \alpha; I = I_0 \left(\frac{\sin \alpha}{\alpha} \right)$
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. $\sin \theta$, $\cos \theta$, $\tan \theta$, etc.
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop

<p>Solution of Ordinary Differential Equations (ODE)</p> <p>First order Differential equation Euler, modified Euler and Runge-Kutta(RK) second and fourth order methods</p>	<p>First order differential equation</p> <ul style="list-style-type: none"> • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion <p>Attempt following problems using RK 4 order method:</p> <ul style="list-style-type: none"> • Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3} \quad \frac{dy}{dx} = -x$ for four initial conditions $x(0)=0, y(0)=-1, -2, -3, -4.$ Plot x vs y for each of the four initial conditions on the same screen for $0 \leq t \leq 15$ <p>The differential equation describing the motion of a pendulum is $\frac{d^2P}{dt^2} = -\sin(P)$. The pendulum is released from rest at an angular displacement α, i. e. $P(0) = \alpha$ and $P'(0) = 0$. Solve the equation for $\alpha = 0.1, 0.5$ and 1.0 and plot P as a function of time in the range $0 \leq t \leq 8\pi$. Also plot the analytic solution valid for small P ($\sin(P) = P$)</p>
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Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al., 3rd Edn., 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press
- Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

PHYSICS-C 2: MECHANICS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. **(6 Lectures)**

Work and Energy: Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. **(4 Lectures)**

Collisions: Elastic and inelastic collisions between particles. Centre of Mass. **(3 Lectures)**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical bodies. **(12 Lectures)**

Elasticity: Relation between Elastic constants. **(3 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **(2 Lectures)**

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell. **(3 Lectures)**

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. Kepler's Laws. Satellite in circular orbit and applications. **(6 Lectures)**

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, **(7 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. **(4 Lectures)**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Mass-energy Equivalence. **(10 Lectures)**

Reference Books:

- An introduction to mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol. 1, C. Kittel, W. Knight, et al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000
 - University Physics. F. W. Sears, M. W. Zemansky, H. D. Young 13/e, 1986, Addison Wesley
 - Physics for scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning
 - Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.
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PHYSICS - C 2 LAB 60

Lectures

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine g and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G. L. Squires, 2015, 4th Edition, Cambridge University Press.

GE - 1: MECHANICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

Vectors: Vector algebra. Scalar and vector products. **(4Lectures)**

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(6Lectures)**

Laws of Motion: Frames of reference. Newton's Laws of motion. **(10Lectures)**

Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. **(6Lectures)**

Rotational Motion: Angular velocity and angular momentum. Torque. **(5Lectures)**

Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). **(8Lectures)**

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. **(6Lectures)**

Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants-Workdoneinstretchingandworkdoneintwistingawire-Twistingcouple on a cylinder. **(8Lectures)**

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. **(7 Lectures)**

- **Reference Books:**

- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley
 - Mechanics Berkeley Physics, v.1: Charles Kittel, et.al. 2007, Tata McGraw-Hill.
 - Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
 - Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
 - University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
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GE - 1 LAB: MECHANICS

60 Lectures

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constant of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g .

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S. Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.