Darrang College (Autonomous), Tezpur-784001

Syllabus for FYUGP

Physics (Minor)

Code: PHY-MN-01014

Approved by :
Board of Studies meeting held on 30-07-2025
&
Academic Council vide Resolution no. 04, dated- 12-08-2025

FYUGP (Physics Minor) Syllabus

Subject: PHYSICS

(The syllabus is approved in the Board of Studies meeting held on 30th July, 2025)

Department of Physics

DARRANG COLLEGE AUTONOMOUS

TEZPUR

W.e.f. August 2025

The syllabus is approved by Academic Council, Darrang College (Autonomous) vide Resolution no. 04, dated- 12-08-2025

AIMS OF FYUGP in PHYSICS

The FYUGP in Physics aims to cultivate not just knowledgeable physicists, but also well-rounded individuals who can contribute to society through their understanding of the physical world and their ability to solve problems creatively. The program mainly focuses on:

1. Solid Foundation in Physics:

To develop a strong base on the subject, the course includes mathematical Physics, mechanics, electricity & magnetism, thermodynamics, electronics, Electromagnetic Theory, classical mechanics, modern physics, statistical mechanics and quantum mechanics.

2. Experimental Skills:

Students learn, design, and conduct experiments in laboratories to demonstrate the concepts, principles, and theories learned in the classroom.

3. Problem-Solving Abilities:

The curriculum encourages students to develop strong and critical analytical and problem-solving skills, enabling them to tackle complex physics problems.

4. Interdisciplinary Learning:

Emphasize Physics as the most critical branch of science to pursue interdisciplinary and multidisciplinary higher education and research in interdisciplinary and multidisciplinary areas.

5. Practical Applications:

Students are encouraged to relate physics concepts to real-world applications and understand the relevance of physics in various fields, including advanced computing, sustainable energy, environmental management, and healthcare.

6. Preparation for Diverse Careers:

The program prepares students for careers in research, academia, industry, and other related fields.

PROGRAM OUTCOME

PO1: Knowledge Acquisition: Students will develop an adequate foundation of theoretical concepts and experimental techniques in physics.

PO2: Analytical and Problem-Solving Skills: Students graduating in Physics will be adept at critically analyzing physics problems, formulating solutions using mathematical and computational tools, and interpreting results.

PO3: Experimental Skills: Students will develop proficiency in conducting experiments, collecting and analyzing data, and drawing meaningful conclusions from observations.

PO4: Communication and presentation skills: Students will be able to communicate effectively about their understanding, ideas and findings to explain natural phenomena.

PO5: Digital and ICT efficiency: Students will be able to use modern ICT tools in a variety of learning environments for knowledge gain, and work places to broaden the capability and improve efficiency.

PO6: Teamwork and leadership: Students will be able to develop teamwork and leadership abilities to work effectively in a co-operative and coordinated manner within diverse teams and peer groups.

PO7: Iinterdisciplinary Awareness: Students will understand how physics principles relate to other scientific disciplines and how interdisciplinary knowledge can contribute to problem-solving.

PO8: Ethics and Values: Students will comply with ethical conduct and adhere to professional standards in learning.

PO9: Employability and entrepreneurial skills: Students will acquire adequate skills and knowledge to become employable.

TEACHING LEARNING PROCESS

The method and practice of teaching for FYUGP in Physics is based on the L+T+P model, where L, T, and P stand for Lecture, Tutorial, and Practical respectively. Lecture classes are aided with prescribed textbooks, e-learning resources, and self-study materials. This approach recognizes the importance of a well-rounded education that includes theoretical knowledge, practical experience, and personal development. Tutorials are interactive sessions where students can ask questions, clarify their doubts, and engage in discussions with their peers and teachers. Tutorials are designed to encourage active learning and to promote critical thinking. The practical courses are designed to provide hands-on experience to students and to help them develop the necessary skills for conducting experiments and record results.

Teaching and Learning Tools:

Traditional Learning Tools like blackboard, textbook, hand notes, visual aids, model etc.

Digital Learning Tools:

Virtual Labs, Educational Videos and Animations E-books and E-readers etc.

EVALUATION/ASSESSMENT

FIRST SEMESTER

Paper	In-semester			End-Semester			Grand Total Marks
	Activity	Marks	Total	Activity	Marks	Total	
Minor	Sessional Examination	15	30	Theory Examination	45	70	100
	Seminar/presentation, assignment, regularity, classroom activity etc.	15		Practical Examination	25		

SECOND SEMESTER

Paper	In-semester			End-Semester			Grand Total Marks
	Activity	Marks	Total	Activity	Marks	Total	
Minor	Sessional Examination	15	30	Theory Examination	45	70	100
	Seminar/presentation, assignment, regularity, classroom activity etc.	15		Practical Examination	25		

1 Credit= 1 hour of Lecture/Tutorial

1 Credit= 2 hours of Practical class

COURSE STRUCTURE

PHYSICS MINOR

Semester	Paper	Theory		Practical		Total	
		Credit	Marks	Credit	Marks	Credit	Marks
I	PHY-MN-01014	3	75	1	25	4	100
II	PHY-MN-02014	3	75	1	25	4	100

FIRST SEMESTER

Physics Minor

Course Name: Mathematical Physics I and Mechanics

Paper Code: PHY-MN-01014

COURSE OBJECTIVES

This course introduces mathematical physics and mechanics. The basic objectives of the course are:

- To introduce essential primary concepts in mathematical physics such as vectors and scalar fields, vector products, calculus of vectors, differential operators which are required for developing insight of the theories of physics.
- To introduce basic concepts of matrix algebra.
- To introduce the concepts of dynamics of particles, energy, oscillation and basic properties of matter which will equip students with the tools required for applying the concepts of physics in practical problems.
- To train the students with concept visualisation through some laboratory practices.

COURSE OUTCOME

On successful completion of the course, students will be able to understand the calculus of vectors and different operators which will be helpful in understanding theories of physics. Through matrix algebra students will be able to compute various matrix operations which are required for solving physical problems. Students will be able to understand and apply the concepts of dynamics of particles, simple harmonic oscillations, basic properties of matter in various problems of physics, technology and engineering. They will be trained in concept realisation through laboratory practices.

FIRST SEMESTER

Physics Minor

STRUCTURE

SEM	Type	Course	Code	Course Type	Credit	Marks Distribution				Total
						Th	Th IA	PR	PR IA	
I	Minor	Mathematical Physics I and Mechanics	PHY-MJ-01014	Theory + Practical	3+1	45	30	20	05	100

SYLLABUS

Title of the course Course code	**Mathematical Physics I and Mechanics** PHY-MN-01014
Total Credit (Theory + Practical)	4 (3+1)
Contact hours: Lecture+Tutorial+Practical	45+0+30
Distribution of Marks	Internal Examination: 30 Final Examination: Theory=45; Practical=25

Topic	Unit	Content	Lecture	Tutorial (Hours)	Practical (Hours)	Total (Hours)
Mathematical Physics I	1	Vector and scalars	2	0	30	75
	2	Vector differentiation	3			
	3	Vector differential operator	5			
	4	Vector Integration	3			
	5	Matrices	2			
Mechanics	1	Reference frames	3			
	2	Central force motion	5			
	3	Conservation laws	4			
	4	Dynamics of rigid bodies	6			
	5	Work and energy	4			
	6	Properties of matter	6			
	7	Oscillations.	2			

FIRST SEMESTER

Physics Minor

DETAIL SYLLABUS

Course Name: Mathematical Physics I and Mechanics.

Existing Base Syllabus: HS Mathematics and Physics.

Course Code: PHY-MN-01014

Theory

Part A: Mathematical Physics I (Credit - 1; No. of lectures: 15, Tutorial: 0)

Unit 1: Vector and scalars (Lectures 2)

Scalar and vector fields, dot and cross products including triple products, their physical significance.

Unit 2: Vector differentiation (Lectures 3)

Ordinary derivative of vectors. Continuity and differentiability, the partial derivative of vectors, applications to problems in Physics.

Unit 3: Vector differential operator (Lectures 5)

Gradient. Divergence and curl - definitions and physical meaning.

Unit 4: Vector Integration (Lectures 3)

Ordinary integrals of vectors - line integral, surface integral and volume integral. Gauss's theorem, Stoke's theorem and Green's theorem (statements only).

Unit 5: Matrices (Lectures 2)

Review of basic concepts. Types of matrices: Hermitian, anti - Hermitian, Unitary, orthogonal, symmetric and skew-symmetric. Diagonalisation of matrices, inverse of a matrix, Eigen values and Eigen vectors, Caley -Hamilton theorem (statement only).

Part B-Mechanics (Credit - 2; No. of lectures: 30, Tutorial: 0)

Unit 1: Reference frames (Lectures 3)

Inertial and non- inertial frames of reference, e.g., rotating frames, laws of Physics in rotating coordinate system. Fictitious forces: Coriolis force and its application, centrifugal force.

Unit 2: Central force motion (Lectures 5)

Motion under central force. Two-body problem and its reduction to one body problem. Kepler's laws of planetary motion, Gravitational Law and Field, Conservative and Non-conservative forces.

Unit 3: Conservation laws **(Lectures 4)**

Dynamics of a system of particles. Centre of mass. Principle of conservation of momentum. Torque. Impulse. Elastic and inelastic collisions between particles. Centre of mass and laboratory frames.

Unit–4: Dynamics of rigid bodies **(Lectures 6)**

Translation and rotational motion, torque, angular momentum. Moment of inertia -general theorem of the moment of inertia, moment of inertia calculation in particular cases - disk, cylinder, and sphere. Kinetic energy of rotation. Motion involving both translation and rotation.

Unit–5: Work and energy **(Lectures 4)**

Work and kinetic energy theorem. Conservative and non-conservative forces. Potential energy. Force as gradient of potential energy. Work done by non- conservative forces.

Unit –6: Properties of matter **(Lectures** 6)

Elastic constants and relation among them, Twisting torque on a cylinder or wire. Bending of beam: Bending moment, cantilever, depression of a cantilever considering the weight of the beam. Kinematics of moving fluids: Poiseuille's equation for flow of a liquid through a capillary tube.

Unit–7: Oscillations **(Lectures 2)**

Simple Harmonic Motion, Differential equation of SHM, Compound Pendulum.

Suggested Reading:

- Essential Mathematical Methods for the Physical Sciences; K.F. Riley and M.P. Hobson, Cambridge University Press.
- Advanced Engineering Mathematics; E. Kreyszic, John Wiley & Sons (New York).
- Mathematical Methods for Physicists; G. B. Arfken, H. J. Weber and F.E. Harris, Elsevier.
- Mathematical Physics-I, K. K Pathak and S. Parasher, Vishal Publication, Jalandhar (Delhi).
- Theoretical Mechanics, M. R. Spiegel, Tata McGraw Hill.
- Mechanics; D. S. Mathur, S. Chand & Company Limited.
- An Introduction to Mechanics, D. Kleppner and R. J. Kolenkow, Tata McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et. al., Tata McGraw-Hill.
- Physics, R. Resnick, D. Halliday and J. Walker, John Wiley & Sons.
- Analytical Mechanics, G. R. Fowles and G. L. Cassiday, Cengage Learning.

Practical **(Credit-1)**

At least five experiments to be performed from the following:

1. To study the motion of spring and calculate (a) spring constant and (b) rigidity modulus.
2. To determine the moment of inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
3. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method).
4. To determine the Young's modulus of the material of a wire by Searle's apparatus.
5. To determine the modulus of rigidity of a wire (static method).
6. To determine the value of g using bar pendulum.
7. To determine the value of g using Kater's pendulum.
8. To determine the height of a building using a sextant.
9. To determine g and velocity for a freely falling body using digital timing technique.

Suggested Reading:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S. Panigrahi and B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- B. Sc. Practical Physics, C. L. Arora, S. Chand, and Company.
- A Text Book on Practical Physics, K. G. Mazumdar, and B. Ghosh.

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SECOND SEMESTER

Physics Minor

Course Name: Mathematical Physics II and Electricity and Magnetism
Course Code: PHY-MN-02014

COURSE OBJECTIVE

This course introduces mathematical physics and Electricity and Magnetism. The basic objectives of the course are:

- To introduce the methods of solving differential equations.
- Electric field from vector calculus point of view and use of potential formulation to solve electrostatic problems.
- Magnetic fields of current carrying conductors, torus, solenoids etc. Study magnetic properties of matter.
- Study and analysis of AC circuits like LCR, and use of network theorems in electrical circuits.

COURSE OUTCOME

After the successful completion of the course, students will be able to understand methods of solving various differential equations appearing in physics. It will give an idea of how to study evolution of a physical system. They will be able to understand electric field and magnetic fields in matter, dielectric properties of matter, magnetic properties of matter, application of Kirchhoff's law in different circuits, and application of network theorem in different circuits. The students will also get accustomed to using mustimeters and potentiometers, and they will be able to determine some of the important physical quantities related to electricity and magnetism for a better understanding of the topic.

STRUCTURE

SEM	Type	Course	Code	Course Type	Credit	Marks Distribution				Total
						Th	Th IA	PR	PR IA	
2	Minor	Mathematical Physics II and Electricity and Magnetism	PHY-MJ-02014	Theory +Practical	3+1	45	30	20	05	100

SYLLABUS

Title of the course **Course code**	**Mathematical Physics II and Electricity and Magnetism** **PHY-MN-02014**
Total Credit (Theory +Practical)	4 (3+1)
Contact hours: Lecture+Tutorial+Practical	45+0+30
Distribution of Marks	Internal Examination: 30 Final Examination: Theory=45; Practical=25

Topic	Unit	Content	Lecture (Hours)	Tutorial (Hours)	Practical (Hours)	Total (Hours)
Mathematical Physics II	1	Curvilinear coordinates	5	0	30	75
	2	Differential equations	8			
	3	Gamma and Dirac Delta function	2			
Electricity and Magnetism	1	Electric field and electric potential	13			
	2	Dielectric properties of matter	4			
	3	Magnetic field	6			
	4	Magnetic properties of matter	2			
	5	Electrical circuits	5			

SECOND SEMESTER

Physics Minor

DETAIL SYLLABUS

Course Name: Mathematical Physics II and Electricity and Magnetism
Existing Base Syllabus: HS Maths and Physics.
Paper Code: PHY-MN-02014

Theory

Part A-Mathematical Physics - II (Credit - 1; No. of lectures: 15, Tutorial: 0)

Unit 1: Curvilinear coordinates (Lectures 5)

Introduction to curvilinear coordinates. Orthogonal curvilinear coordinates. Examples of spherical, cylindrical and plane polar coordinates. Line element- transformation from Cartesian to curvilinear coordinates (spherical and cylindrical). Gradient, divergence and curl in spherical and cylindrical coordinates.

Unit 2: Differential equations (Lectures 8)

First Order and Second Order Differential equations. First Order Differential Equations and Integrating Factor (physical examples: radioactive decay, Newton's law of cooling, particle falling under gravity through a resistive medium). Homogeneous and inhomogeneous differential equations. Concept of initial/boundary conditions. Solutions of second order ODE with constant coefficients - complementary function simple harmonic oscillation, forced vibration). Wronskian- definition and its use to check linear independence of 2nd order homogeneous linear differential equation. Partial differential equations (PDE) (physical examples – wave equation, diffusion equation, Laplace and Poisson equation – introduction only). Exact and inexact differentials. Concept of variable separation in a PDE.

Unit 3: Gamma and Dirac Delta function (Lectures 2)

Definition and properties of Gamma function and Dirac Delta function.

Part B: Electricity and Magnetism (Credit - 2; No. of lectures: 30; Tutorial: 0)

Unit 1: Electric field and electric potential (Lectures - 13)

Electrostatic field, electric flux. Gauss's law. Application of Gauss's law to charge distributions with planar, spherical and cylindrical symmetries. Conservative nature of electrostatic field. Electrostatic potential. Electrostatic energy of a system of charges. Electrostatic boundary conditions. Laplace's and Poisson's equations. Uniqueness theorem. Application of Laplace's equation involving planar, spherical and cylindrical symmetries.

Potential and electric field of a dipole. Force and torque on a dipole. Capacitance of a system of charged conductors. Parallel plate capacitor. Capacitance on an isolated conductor.

Unit 2: Dielectric properties of matter (Lectures -4)

Electric field in matter. Polarisation, polarisation charges. Electrical susceptibility and dielectric constant. Capacitor (parallel plate, spherical and cylindrical) filled with dielectric. Displacement vector, D. Relation between E, P and D. Gauss's law in dielectrics.

Unit 3: Magnetic field (Lectures -6)

Magnetic force on a point charge, definition and properties of magnetic field B. Curl and divergence. Vector potential, A. Magnetic scaler potential. Magnetic force on (i) a current carrying wire and (ii) between two elements. Torque on a current loop in a uniform magnetic field. Biot-Savart's law and its simple application: straight wire and circular loop. Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole). Ampere's circuital law and its application to (i) solenoid and (ii) torus.

Unit–4: Magnetic properties of matter (Lectures -2)

Magnetization vector, M. Magnetic intensity, H. Magnetic susceptibility and permeability. Relation between B, H and M. Ferromagnetism, B-H curve and hysteresis.

Unit–5: Electrical circuits (Lectures -5)

AC circuits: Kirchhoff's laws for AC circuits. Complex reactance and inductance. Series LCR circuits and parallel LCR circuits: (i) phasor diagram, (ii) resonance, (iii) power dissipation, (iv) quality factor, and (v) band width. Ideal constant-voltage and constant-current sources. Thevenin theorem and Norton theorem (only statements and solving of related problems).

Practical (Credit-1)

At least five experiments must be performed from the following:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) Checking electrical fuses.
2. To study the characteristics of a series RC circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton Theorems.
8. To verify the superposition
9. To verify maximum power transfer theorems.
10. To determine the self-inductance of a coil by Anderson's bridge.
11. To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

12. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.

Suggested Readings

- Essential Mathematical Methods for the Physical Sciences; K. F. Riley and M. P. Hobson, Cambridge University Press.
- Advanced Engineering Mathematics; E. Kreyszic, John Wiley & Sons (New York)
- Mathematical Methods for Physicists; G. B. Arfken, H. J. Weber and F.E. Harris, Elsevier
- Mathematical Physics, H. K. Dass and Dr. Rama Verma, S. Chand Publication.
- Mathematical Physics-I; Krishna K. Pathak and Sangeeta Prasher, Vishal Publishing Co, Jalalandhar (Delhi).
- Introduction to Electrodynamics, D. J. Griffiths.
- Electricity and Magnetism [With electromagnetic theory and special theory of relativity],
- D. Chattopadhyay and P. C. Rakshit, 2013, New Central Book Agency (P) Limited.
- Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and S. R. Choudhury, 2012, Tata Mcgraw.
- Schaum's outline of Theory and Problems of Electromagnetics, J. A. Edminister.
- Electromagnetics, B. B. Laud, New Age International Publishers.
- Feynman Lectures Vol. 2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Elements of Electromagnetics, M. N. O. Sadiku, 2008. Pearson Education.
- Electricity and Magnetism, J. W. Fewkes and J. Yarwood, Vol. I, 1991, Oxford Univ. Press.

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