Morigaon College (Autonomous)
Morigaon: Assam

SYLLABUS
Physics
(3rd Semester)

Four-Year Undergraduate Programme (FYUGP)

Subject: Physics (Major/Minor)

Semester -III

Course Name: Mathematical Methods-III, Electricity & Magnetism

Existing base syllabus: HS Maths and Physics

Course Code: PHY-CORE(MJ/MN)-MC-0300104

Syllabus showing each unit against class number and Marks

Total credit:04 (T:03, P:01)

Theory: (Credit: 03, Total Lecture=45)

Total Mark: 100 (ET: 45, INT:30, PRAC:25)

Part A: Mathematical Methods-III (Credit: 01, Total Lecture=15)

Topic	Details	Lectures
Unit 1: Matrix formalism	Introduction, row and column matrix, Types of matrices and properties, Matrix algebra: Addition, subtraction, multiplication. Determinant, Rank. Inverse of a matrix, Co-factor, Adjoint of a matrix, Characteristic equation, Eigen values and Eigen vector of a matrix. Caley-Hamilton's theorem, Matrix method for homogeneous linear solution.	06
Unit 2: Curvilienar co-ordinates	Introduction, scale factor, line, surface and volume element, Polar co-ordinate, cylindrical co-ordinate, spherical co-ordinate. Divergence, gradient and curl in curvilinear co-ordinates.	05
Unit 3: Beta and gamma function	Introduction to beta and gamma functions, Properties and applications, Relation between gamma and beta functions, Numerical Problems	04

Part B: Electricity and Magnetism (Credit: 02, Total Lecture=30)

Topic	Details	Lectures
Unit 1: Fundamental of electrostatic phenomena	Electric field, electric potential, Potential and field due to a dipole, Potential and field due to a quadrupole, Gauss's law (both integral and differential form) and its applications	07
Unit 2: Dielectric and capacitance	Di-electric, Effect of dielectric in capacitance, Parallel plate capacitor, Spherical capacitor, Basic idea of supercapacitor.	03
Unit 3: Voltaic cells	Nernst theory of Electrode Potential, Theory of voltaic cell, Dry cell, Basics idea of Standard cell and atomic battery.	04
Unit 4: Current electricity and Measurement tools	Current and Current density, Ohm's law in vector form. Galvanometer, sensitivity, Ammeter, Voltmeter, Ballistic Galvanometer, Potentiometer principle and basic applications, Multi-meter and its uses	06
Unit 5: Magnetism and magnetic Materials	Magnetic force on a point charge, Motion of charge particle in electro-magnetic field. Scalar and vector potential. Theory of magnetism (dia, para, ferro). Different types of magnetic materials (Basics idea only)	04
Unit 6: Electromagnetic induction and AC current	Faraday's law, self induction and mutual induction, $M_{12}=M_{21}$, Lenz's law, Energy stored in a solenoid. LCR series and Parallel circuit, Resonance condition, Q-factor, Kirchhoff's Law in AC, Anderson's bridge, Maxwell's bridge, De-sauty bridge, Wheastone's bridge, Displacement current and Ampere's circuital law, Maxwell's equations.	06

Practical (Credit:01)

Minimum 5 experiments to be done:

1. Verify Ohm's law and determine the unknown resistance from the I-V curve
2. Convert a Galvanometer to an Ammeter
3. To study the discharging curve of a capacitor.
4. Determine the unknown resistance using meter bridge.
5. To study the resonance frequency and Q-factor in LCR series circuit
6. To study the resonance frequency and Q-factor in LCR parallel circuit
7. Determine the unknown inductance using Anderson Bridge
8. Determine the capacitance using De-Sauty's bridge
9. Study the variation of magnetic field from a solenoid and plot $\frac{dB}{dx}$

Learning Outcome:

On successful completion of the course, the students will be able to learn about matrix algebra, dirac delta function and beta and gamma functions. They will be able to understand electric field and magnetic field in matter, di-electric properties of matter, DC and AC current. The students will also get accustomed to use multi-meters, potentiometer, galvanometer etc., and they will be able to determine sum of the important physical quantities related to electricity and magnetism for a better understanding of the topic.

Course Objective:

* To introduce the concepts in matrix, curvilinear co-ordinate and beta and gamma functions
* To understand the concepts of electrical and magnetic field and their applications
* Introduction to electric and magnetic materials
* Introduction to energy storage devices

Reading references:

[1] Mathematical Physics, B.S. Rajput, S.Chand & Com. Ltd.
[2] Introduction to electrodynamics, D.J Griffith, P. Hall of India
[3] Electricity and Magnetism, K.K. Tiwary, S.Chand & Com. Ltd.
[4] Mathematical Physics, HK Dass, R. Verma & R. Verma, S. Chand & Com. Ltd.
[5] Mathematical Methods for Physicists, Arfken, Weber & Harris, Elsevier
[6] Electricity and Magnetism, R Murugeshan, S. Chand & Com. Ltd.
[7] Electricity and Magnetism, D.C. Tayal, Himalaya Publishing House
[8] The Feynman Lectures on Physics (Vol. 1), Feynman, Leighton & Sands, Pearson Publication
[9] Foundations of Electromagnetic Theory, JR Reitz, FJ Milford & RW Christy, Pearson Publication

Particulars of course designer:

[1] Babul Talukdar, Asso. Professor, Morigaon College, Morigaon Assam
[2] Dr. Hemanga Jyoti Sarmah, Asst. Professor, Morigaon College, Morigaon Assam
[3] Ujjal Medhi, Asst. Professor, Morigaon College, Morigaon Assam
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Four-Year Undergraduate Programme (FYUGP)

Subject: Physics (Major)
Semester -III
Course Name: Wave and Optics
Existing base syllabus: HS Physics
Course Code: PHY-CORE(MJ)-MC-0300204

Syllabus showing each unit against class number and Marks

Total credit:04 (T:03, P:01)

Theory: (Credit: 03, Total Lectures=45)
Total Mark: 100 (ET: 45, INT:30, PRAC:25)

Topic	Details	Lectures
Unit 1: Harmonic oscillation	Simple harmonic motion, differential equation of SHM, energy in SHM, Simple pendulum, coupled pendulum	04
Unit 2: Lissajeous figure	Lissajous figures, Composition of of two simple harmonic waves, Effect of frequency and phase difference, Uses of Lissajous figures	04
Unit 3: Free, damped, forced vibrations	Free vibration, damped vibration, forced vibrations, resonance, Quality factor	04
Unit 4: Velocity of sound	Origin of sound, Importance of Material medium for sound propagation, velocity of longitudinal wave, Newton's formula & Laplace's correction, Doppler effect, Effect of temperature, pressure, density of medium, humidity.	05
Unit 5: Stationary wave	Stationary wave and its properties, analytical treatment, Energy of stationary waves	03
Unit 6: Vibration in string and air column	Velocity of transverse wave along a stretched string, Melde's experiment, Organ pipe: closed and open-end organ pipe, Intensity of sound and its measurement	04
Unit 7: Interference	Theory of interference, Young's double-slit experiment, Fresnel bi-prism, Lloyd's single mirror, Newton's ring experiment	04
Unit 8: Diffraction	Introduction, Fresnel's half-period zones of a plane wavefront and their applications, zone plate, Different classes of diffraction phenomena, Fresnel's half-period elements for cylindrical wavefront, Fresnel diffraction at single edge, Fresnel's diffraction: narrow rectangular aperture, narrow obstacle, circular aperture, opaque circular disc. Fraunhofer diffraction in a single slit and double slit, Plane diffraction grating, Angular dispersive power in grating, resolving power of grating, resolving power of prism spectrometer.	12
Unit 9: Polarization	Introduction, Transverse nature of light wave, Polarization methods: Reflection, refraction, double refraction, Nicol prism, Malus law, Polaroid: polarizer and analyzer, Babinet's compensator. Plane polarized, circularly polarized and elliptically polarized light. Rotatory polarization.	09

	Specific rotation, Polarimeter.	
Unit 10: Modern Optics (Basics)	Introduction to LASER, Holography and Optical Fibre (Basic idea only).	03

Practical (Credit:1)
Minimum 5 experiments to be done

1. To determine the unknown wavelength of Na source using Newton's ring method.
2. To demonstrate the Lissajous figure in CRO, using different combination of R and C.
3. Determine the refractive index of material of prism.
4. Determine the resolving power of a grating and find out wavelength of hydrogen alpha.
5. Determine the unknown wavelength of Na light using Fresnel bi-prism.
6. Verify the Malus law, using Polarizer and Analyzer.
7. To determine the spring constant of a spring in harmonic motion.
8. Determine the unknown wavelength of Na source using diffraction grating.
9. Determine the unknown wavelength of Hg source using diffraction grating.
10. Determine the unknown wavelength of Ne source using diffraction grating.
11. To determine the specific rotation of a sugar solution using Polarimeter.

Course Outcome:

On successful completion of the course, the students will be able to learn about understand simple harmonic oscillation and superposition principles, classical wave equation in transverse and longitudinal waves, Lissajous Figure, velocity of sound. In optics, students will learn about the interference, diffraction and polarization. This physical phenomena related to wave and optics will be covered via laboratory experimentation.

Reading references:

[1] Optics, A. Ghatak, Tata McGraw Hill

[2] A textbook on Light, B. Ghosh & KG Mazumdar, Sreedhar Publications

[3] Sound, Brij Lal and Subrahmanyam, Vikash Publishing house

[4] Sound, K. Bhattacharyya, Shreedhatr Prakashan

[5] The physics of vibrations and waves, HJ Pain, John Wiley and Sons.

[6] The Feynman Lectures on Physics (Vol. 2), Feynman, Leighton & Sands, Pearson Publication

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Four-Year Undergraduate Programme (FYUGP)

Subject: Physics (SEC)
Semester -III
Course Name: Semiconductor Devices
Existing base syllabus: HS Maths and Physics
Course Code: SEC-PHY-MC-0300103

Syllabus showing each unit against class number and Marks

Total credit:04 (T:03, P:01)

Theory: (Credit: 03, Total Lecture=45)
Total Mark: 75 (ET: 30, INT:20, PRAC:25)

Serial No./Chapter Name	Details	Lectures
1. Basic Introduction	Class of materials: Metal, semiconductor, and insulator; intrinsic and extrinsic semiconductor; doping; P-type, N-type semiconductor. Diffusion and drift current.	8
2. PN semiconductor diode	Characteristics of diode, basic properties. Solar cell, Zener diode, Photo-cell. Uses of diodes: Rectification (half-wave, full-wave, Wien bridge), regulated power supply.	8
3. Transistors	Basic principles, working of transistors. Transistor characteristics. Transistor as an amplifier. Q-point, load line. RC-Coupled amplifier. Basic ideas of FET and MOSFET.	8
4. **OPAMP**	Basics of OPAMP, Feedback in amplifier, OPAMP as an adder, subtractor, integrator, etc.	6

Practical (Credit 1):

1. To check the type of semiconductor using a Hall measurement setup.
2. To measure the temperature-dependent resistance using a four-probe setup.
3. To study the characteristics of a PN semiconductor diode.
4. To study the input and output characteristics of an OPAMP.
5. Design a Wien bridge rectifier setup.
6. To study the efficiency of a solar cell.
7. Design an RC-coupled amplifier and study its frequency response.
8. To design an OPAMP as an integrator.
9. To design an OPAMP as a differentiator.

Suggested readings:

1. Semiconductor devices, S.M. Sze, 2nd Edition, 2002, Wiley
2. Principles of electronics, Mehta and Mehta, S. Chand

Learning objectives:

* Students will be able to explain the behavior of semiconductors, including energy bands, carrier statistics, and transport phenomena.
* To introduce students to basics semiconductor devices and their hands-on practice
* Students will develop problem-solving skills in the context of semiconductor devices and circuits.

Learning outcomes:

* Students will be prepared for advanced studies or industry roles in semiconductor engineering, including device design, fabrication, and testing.
* Skill will boast up, which may favour job opportunities in the field of semiconductor devices and electronics

Subject: **Skill Enhancement Course**
Semester **-III**
Course Name: **Biophysics**
Existing base syllabus: **NA**
Course Code: **SEC-PHY-MC-0300203**

Syllabus showing each unit against class number and Marks

Total credit:03 (T:03, P:00)

Theory: **(Credit: 03, Total Lecture=45)**
Total Mark: 75 (ET: 45, INT:30)

Unit 1: Molecular Interaction: covalent, ionic bond, Resonance bond, H-bond; Intermolecular interaction: Van der Waal type, Effect of the medium, screening of field Hydro-phobic/philic interaction,

Unit 2: Bilayer formation, Physics of Biopolymers: different models that can explain the basic properties of biopolymers

Unit 3: Physics of Nucleic Acid (DNA); Physics of Amino Acid (Proteins)

Unit 4: Physical methods for shape, size and mass determination of bio-molecules (Dynamic/Static Laser Light Scattering)

Unit 5: X-ray scattering, Small angle neutron scattering

Unit 6: Spectroscopic methods: Infrared, Ultraviolet -Visible, Fluorescence

Unit 7: NMR, MRI

Unit 8: Physics of Imaging: concept of pixel, voxel, components of image

Unit 9: Cellular electricity, Nernst- Planck equation, Donnan equilibrium, Goldman equation

Unit 10: Action Potential, Ion-channel, Propagation of Nerve impulse

Unit 11: Cable model, Hodgkin-Huxley model, Noble model for heart

Unit 12: Neural Network

Suggested Books

1. Biophysics an Introduction by Rodney Cotterill
2. Biophysics by Roland Glaser
3. Advance techniques in Biophysics by Arrondo
4. Protein folding kinetics (Biophysical methods) by B. Nolting
5. Applied Biophysics by Tom Waigh