MURSHIDABAD UNIVERSITY

Berhampore Murshidabad* West Bengal*

DEPARTMENT OF PHYSICS

CURRICULUM & CREDIT FRAMEWORK
FOR
FOUR YEARS UNDER-GRADUATE SEMESTERIZED PROGRAMME IN PHYSICS

(HONOURS/HONOURS WITH RESEARCH)
(UNDER NEP 2020)

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With Effect from the Academic Session: 2025-2026

B.Sc.-Physics, MU

Semester and Coursewise credit distribution in B.Sc. Physics under NEP 2020

COURSE STRUCTURE OF SEMESTER-I

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
I	Mathematical Physics-I	UG-PHS-M-T-101	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-101	30	1	20
	Mathematical Physics-I	UG-PHS-MI-T-101	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-MI-P-101	30	1	Practical 20
	Physics in Everyday Life	UG-PHS-MDC-T-101	45	3	60 (End SEM-45 +Internal-15)
	Ability Enhancement Course	UG-PHS-AEC-T-101	60	4	80
	Electrical Circuits and Network Skills	UG-PHS-SEC-T-101	45	3	60 (End SEM-45 +Internal-15)
	Value Added Course	UGPHS-VAC-T-101	30	2	40

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COURSE STRUCTURE OF SEMESTER-II

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
II	Mechanics and Special Theory of Relativity	UG-PHS-M-T-201	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-201	30	1	20
	Mathematical Physics-I	UG-PHS-MI-T-201	45	3	60 (End SEM-40 +Internal- 20)
		UG-PHS-MI-P-201	30	1	Practical 20
	Renewable Energy and Energy Harvesting	UG-PHS-MDC-T-201	45	3	60 (End SEM-45 +Internal- 15)
	Ability Enhancement Course	UG-PHS-AEC-T-201	60	4	80
	Basic Instrumentation and Their Uses	UG-PHS-SEC-T-201	45	3	60 (End SEM-45 +Internal- 15)
	Value Added Course	UGPHS-VAC-T-201	30	2	40

COURSE STRUCTURE OF SEMESTER-III

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
III	Waves and Optics	UG-PHS-M-T-301	45	3	60 (End SEM-40 +Internal- 20)
		UG-PHS-M-P-301	30	1	20
	Electricity and Magnetism	UG-PHS-M-T-302	45	3	60 (End SEM-40 +Internal- 20)
		UG-PHS-M-P-302	30	1	20
	Mechanics	UG-PHS-MI-T-301	45	3	60 (End SEM-40 +Internal- 20)
		UG-PHS-MI-P-301	30	1	Practical 20
	Frontiers in Physics	UG-PHS-MDC-T-301	45	3	60 (End SEM-45 +Internal- 15)
	Nanomaterials and Applications	UG-PHS-SEC-T-301	45	3	60 (End SEM-45 +Internal- 15)
	Value Added Course	UGPHS-VAC-T-301	30	2	40

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COURSE STRUCTURE OF SEMESTER-IV

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
IV	Mathematical Physics-II	UG-PHS-M-T-401	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-401	30	1	20
	Thermal Physics	UG-PHS-M-T-402	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-402	30	1	20
	Analog Electronics	UG-PHS-M-T-403	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-403	30	1	20
	Solid State Physics	UG-PHS-M-T-404	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-404	30	1	20
	Mechanics	UG-PHS-MI-T-401	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-MI-P-401	30	1	Practical 20

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COURSE STRUCTURE OF SEMESTER-V

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
V	Mathematical Physics-III	UG-PHS-M-T-501	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-501	30	1	20
	Modern Physics	UG-PHS-M-T-502	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-502	30	1	20
	Quantum and Atomic Physics	UG-PHS-M-T-503	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-503	30	1	20
	Digital Electronics	UG-PHS-M-T-504	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-504	30	1	20
	Waves and Optics	UG-PHS-MI-T-501	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-MI-P-501	30	1	Practical 20

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COURSE STRUCTURE OF SEMESTER-VI

SEM	Course Name	Course Code	Course wise lecture	Credit	Marks
VI	Nuclear and Particle Physics	UG-PHS-M(DSE)-T-601	60	4	80 (End SEM-60 +Internal-20)
	Classical Dynamics	UG-PHS-M(DSE)-T-602	60	4	80 (End SEM-60 +Internal-20)
	Statistical Mechanics	UG-PHS-M-T-603	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-603	30	1	20
	Electromagnetic Theory	UG-PHS-M-T-604	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-M-P-604	30	1	20
	Waves and Optics	UG-PHS-MI-T-601	45	3	60 (End SEM-40 +Internal-20)
		UG-PHS-MI-P-601	30	1	Practical 20

B.Sc.-Physics, MU

NEP curriculum for Semesterized Under-Graduate Course in Physics

SEMESTER-I

B.Sc.-Physics, MU

PHYSICS

MURSHIDABAD UNIVERSITY

Paper Code: UG-PHS-M-T-101
Topic name: MATHEMATICAL PHYSICS-I
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Calculus: Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). **(5 Lectures)**

Differential Equation: First Order Differential Equations and Integrating Factor. 2^{nd} order Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(5 Lectures)**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(5 Lectures)**

Vector Calculus: (a) Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. **(5 Lectures)**

(b) Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(5 Lectures)**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. 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). **(5 Lectures)**

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(3 Lectures)**

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a

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Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and non-degenerate). Cayley-Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Homogeneous Differential Equations. Functions of a Matrix.

(5 Lectures)

Introduction to probability: Independent random variables: Sample space and Probability distribution functions. Binomial, Gaussian, and Poisson distribution with examples. Mean and variance. **(5 Lectures)**

Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

(2 Lectures)

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7thEdn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Higher Enginering Mathematics, B. S. Grewal, Khanna Publisher.
5. Vector Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outlines Series
6. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
7. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
8. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
9. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
10. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
11. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press.
12. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.
13. Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani.

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Paper Code: UG-PHS-M-P-101
Topic name: MATHEMATICAL PHYSICS-I (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Practicals:

1. Introduction and Overview

Computer architecture and organization, memory and Input/output devices.

2. 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.

3. Errors and error Analysis

Truncation and round of errors, Absolute and relative errors, Floating point computations.

4. Introduction to plotting graphs with Gnuplot / QtiPlot (or some other GUI based free software like Grace, Origin etc.)

Basic 2D graph plotting – plotting functions and data files, fitting data using gnu plot's fit function, polar and parametric plots, modifying the appearance of graphs, exporting plots.

5. Introduction to programming in python:

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, file handling, iterables, compound statements, indentation in python, the if-else if-else block, for and while loops, nested compound statements.

6. Programs

(a) Elementary calculations with different type of data e.g., area and volume of regular shapes using formulae. Creation and handling one dimensional array. Sum and average of a list of numbers stored in array, finding the largest and lowest number from a list, swapping two data in a list, sorting of numbers in an array using bubble sort, insertion sort method. Calculation of term value in a series and finding the other terms with a seed (value of particular term) and calculation of different quantities with series. Convergence and accuracy of series. Introduction of three-dimensional array. Simple calculations of matrices e.g., addition, subtraction, multiplication.

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(b) Curve fitting, Least square fit, Goodness of fit, standard deviation

(c). Ohms law to calculate R,

(d). Hooke's law to calculate spring constant

Reference Books

1. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn. , 2012, PHI Learning Pvt. Ltd.
2. Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
3. Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
4. Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Huff, 2015, O'Rielly A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T.Pang, 2ndEdn., 2006,Cambridge Univ. Press Computational Physics, Darren Walker, 1stEdn., 2015, Scientific International Pvt. Ltd.

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-T-101
Topic name: MATHEMATICAL PHYSICS-I
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). **(5 Lectures)**

Differential Equation:

First Order Differential Equations and Integrating Factor. 2^{nd} order Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(5 Lectures)**

Calculus of functions of more than one variable:

Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(5 Lectures)**

Vector Calculus:

(a) Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. **(5 Lectures)**

(b) Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(5 Lectures)**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector

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fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). **(8 Lectures)**

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(5 Lectures)**

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and non-degenerate). Cayley-Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Homogeneous Differential Equations. Functions of a Matrix.
(5 Lectures)

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **(2 Lectures)**

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Paper Code: UG-PHS-MI-P-101
Topic name: MATHEMATICAL PHYSICS-I (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Practicals:

1. Introduction and Overview

Computer architecture and organization, memory and Input/output devices.

2. 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.

3. Errors and error Analysis.

Truncation and round of errors, Absolute and relative errors, Floating point computations.

4. Introduction to plotting graphs with Gnuplot / QtiPlot (or some other GUI based free software like Grace, Origin etc.)

Basic 2D graph plotting – plotting functions and data files, fitting data using gnuplot'sfit function, polar and parametric plots, modifying the appearance of graphs, exporting plots.

5. Introduction to programming in python:

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, file handling, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements.

6. Programs

(a) Elementary calculations with different type of data e.g., area and volume of regular shapes using formulae. Creation and handling one dimensional array. Sum and average of a list of numbers stored in array, finding the largest and lowest number from a list, swapping two data in a list, sorting of numbers in an array using bubble sort, insertion sort method. Calculation of term value in a series and finding the other terms with a seed (value of particular term) and calculation of different quantities with series. Convergence and accuracy of series. Introduction of three-dimensional array. Simple calculations of matrices e.g., addition, subtraction, multiplication.

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(b) Curve fitting, Least square fit, Goodness of fit, standard deviation

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2. Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
3. Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
4. Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Huff, 2015, O'Rielly A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T.Pang, 2ndEdn., 2006,Cambridge Univ. Press Computational Physics, Darren Walker, 1stEdn., 2015, Scientific International Pvt. Ltd.

B.Sc.-Physics, MU

Paper Code: UG-PHS-MDC-T-101
Topic name: Physics in Everyday Life
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –10]
Theory: 45 Lectures

(All the topics given below will be taught in qualitative approach and with examples as much as possible)

Course Objectives:

- *To provide an overview of key physics concepts and principles.*
- *To demonstrate the relevance of physics in everyday life.*
- *To develop critical thinking skills in analysing and explaining real-world phenomena using physics principles.*
- *To foster an appreciation for the scientific method and the role of physics in advancing society.*

Physical World & Measurement: Physics - scope and excitement, nature of physical Law, physics technology and society. Need for measurement, units of measurement, Systems of units, SI units, Fundamental and derived units, length, mass and time measurement, accuracy and precision of measuring instruments, error in measurement.
Dimensions of physical quantities, dimensional analysis and its applications. **(8 Lectures)**

Scalar and vector quantities: Scalar and vector quantities, position and displacement vectors, general vectors and their notations, equality of vectors, multiplication of vectors by a real number, addition and subtraction of vectors. Relative velocity. Unit vector, resolution of a vector in a plane - rectangular components. Scalar and vector product. **(8 Lectures)**

Mechanics and Motion: Newton's laws of motion and their applications, Projectile motion, Forces in equilibrium, Physics of transportation and motion. **(6 Lectures)**

Energy and Its Transformations: Conservation of energy, Work and power, Potential and kinetic energy, Energy transfers and transformations. **(5 Lectures)**

Waves and Sound: Periodic motion-period, frequency, displacement as a function of time, Periodic functions. Simple harmonic motion (S.H.M) and its equation.

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Properties of waves, longitudinal and transverse waves, Sound waves and their characteristics, Intensity, Pitch, loudness, and their units, the Doppler effect, Physics of music and musical instruments. **(8 Lectures)**

Light and Optics: Electromagnetic spectrum, Reflection, refraction, and diffraction, Concave and convex lenses – focal length, power of a lens, refractive index-defects of the eye – myopia, hypermetropia, presbyopia and astigmatism and their correction by lens.

Scattering (elementary ideas only) – blue color of sky, twinkling of stars, Mirage –rainbow.

(10 Lectures)

Reference Books:

1. Mechanics Berkeley Physics, Vol-1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
2. References 1. Louis A Bloomfield, How Things Work: The Physics of Everyday Life, 6th Edition, John Wiley & Sons,1997.
3. Classical Mechanics and Properties of Matter, Gupta, Books and Allied (P) Ltd.
4. Principles of Acoustics, Ghosh, Shreedhar Publisher.
5. Snatak Padartha Bigyan (Part -1 & 2), Dasgupta, Book Syndicate.
6. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
7. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill.
8. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
9. Modern Atomic and Nuclear Physics, A. B. Gupta, Books & Allied Ltd; 2nd Revised edn.
10. A Text Book On Light By B.Ghosh& K.G Mazumdar, Sreedhar Publishers.
11. Concepts of Physics, H C Verma, Vol 1 & 2, Bharati Bhawan.
12. Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani.

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Paper Code: UG-PHS-SEC-T-101
Topic name: ELECTRICAL CIRCUITS AND NETWORK SKILLS
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial–10]
Theory: 45 Lectures

Course Objectives:

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode.

Basic Electricity Principles:

Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multi-meter, voltmeter and ammeter. **(5 Lectures)**

Understanding Electrical Circuits:

Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

(8 Lectures)

Electrical Drawing and Symbols:

Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. (**5 Lectures)**

Generators and Transformers:

DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(5 Lectures)**

Electric Motors:

Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(5 Lectures)**

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Solid-State Devices:

Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. **(5 Lectures)**

Electrical Protection:

Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device). **(5 Lectures)**

Electrical Wiring:

Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

(7 Lectures)

Reference Books:

1. A Text book in Electrical Technology - B L Theraja - S Chand & Co.

2. A Text book of Electrical Technology - A K Theraja

3. Performance and design of AC machines - M G Say ELBS Edn,

4. Electrical Circuits and Network Skills, R.S. Khadayate, S.V. Borse, K.G. Kolhe, et al, Prashant Publications.

5. Undergraduate Physics Companion (Vol-2), S. Pal, 1st edition 2022, Suhrid Prakashani.

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NEP curriculum for Semesterized Under-Graduate Course in Physics

SEMESTER-II

B.Sc.-Physics, MU

PHYSICS

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Paper Code: UG-PHS-M-T-201
Topic name: Mechanics and Special Theory of Relativity
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial–15]
Theory: 45 Lectures

Fundamentals of Dynamics: Reference frames, Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass (CM), equation of motion of the CM. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket, Motion of a projectile in Uniform gravitational field.Two-body problem and its reduction to one-body problem and its solution. **(5 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. Work done by non-conservative forces. Law of conservation of Energy. **(3 Lectures)**

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. **(2 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 and spherical bodies. Moments of Inertia and products of Inertia, parallel and perpendicular axes theorem and their applications for symmetric bodies. Principal moments and axes. Kinetic energy of rotation. Motion involving both translation and rotation. **(9 Lectures)**

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. Work done in stretching and work done in twisting a wire. Twisting torque on a Cylinder or Wire. **(3 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Basic idea of Viscosity. Stokes Law (no rigorous derivation). Terminal velocity. Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Equation of continuity. Euler's Equation. Bernoulli's Theorem. **(2 Lectures)**

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.Motion of a particle under a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Orbit under inverse square law - Kepler's laws. Brief discussion of

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motion in a non-inverse square central force field. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts. **(7 Lectures)**

Waves & Oscillations: 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, sharpness of resonance; power dissipation and Quality Factor. **(5 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. Expressing velocity and acceleration in non-Cartesian coordinate systems (plane polar, spherical, and cylindrical). **(4 Lectures)**

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulatesof Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events.Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wavenumber. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles.Mass-energy Equivalence. Relativistic Doppler Effect. Relativistic Kinematics. Transformationof Energy and Momentum. **(5 Lectures)**

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
6. Classical Mechanics, H. Goldstein, C.P. Poole, J. Safko, Pearson, 2011
7. A Treatise on General Properties of Matter, H. Chatterjee, R. Sengupta, New Central Book Agency.
8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
9. An Introduction to Classical Mechanics, R G Takwale & P S Puranik, TMG Hill.
10. Classical Mechanics, S.L. Gupta, V. Kumar, H.V. Sharma, Pragati Prakashan, 2019
11. Vibrations, Waves and Acoustics, D Chattopadhyay, P C Rakshit, Books and Allied Pvt. Ltd.
12. Advanced Acoustics, D P Roychaudhuri and P Banerjee, The New Book Stall, 2009
13. Introduction to Special Relativity, Robert Resnick, Wiley, 2021
14. Concepts of Modern Physics - Arthur Beiser - 8th/Ed. – 2024.
15. Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-201
Topic name: Mechanics and Special Theory of Relativity (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Measurements of length, diameter, area of cross-section & volume using slide calipers,screw gauge and travelling microscope.
2. To determine the Moment of Inertia of a Flywheel/ a rigid body.
3. To determine g and velocity for a freely falling body using Digital Timing Technique
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus of the material of a bar by flexure method
6. To determine the Modulus of Rigidity of a Wire byMaxwell's needle/dynamical method.
7. To determine the elastic Constants of a wire by Searle's method.
8. To determine the value of g using Bar Pendulum /Kater's Pendulum.
9. To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork
10. Measurement of coefficient of viscosity by Stoke's method.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House.

2. A Text Book of Practical Physics, I.Prakash& Ramakrishna,11thEdn,2011,KitabMahal.

3.Engineering Practical Physics, S.Panigrahi&B.Mallick,2015,CengageLearningIndiaPvt.Ltd.

4. Practical Physics,G.L.Squires,2015, 4thEdition,CambridgeUniversityPress.

5. Practical Physics, D Chattopadhyay, P C Rakshit and B Saha, Books and Allied Pvt. Ltd.

6. Advanced Practical Physics, B Ghosh and K G Mazumdar, Sreedhar Publishers.

7. B. Sc. Practical Physics, Harnam Singh and P S Heme, S Chand and Company Limited.

8. B. Sc. Practical Physics, C L Arora, S Chand and Company Limited.

B.Sc.-Physics,MU

Paper Code: UG-PHS-MI-T-201
Topic name: MATHEMATICAL PHYSICS-I
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Course Objectives:

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). **(5 Lectures)**

Differential Equation:

First Order Differential Equations and Integrating Factor. 2^{nd} order Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. **(5 Lectures)**

Calculus of functions of more than one variable:

Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(5 Lectures)**

Vector Calculus:

(a) Recapitulation of Vector Algebra. Idea of linear independence, completeness, basis and representation of vectors. Properties of vectors under rotations. Scalar product and its invariance under coordinate rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. **(5 Lectures)**

(b) Vector Differentiation: Scalar and Vector fields. Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(5 Lectures)**

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Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. 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). **(8 Lectures)**

Orthogonal Curvilinear Coordinates:

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(5 Lectures)**

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew- Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix. Eigen-values and Eigenvectors (Degenerate and non-degenerate). Cayley-Hamiliton Theorem. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Homogeneous Differential Equations. Functions of a Matrix.

(5 Lectures)

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **(2 Lectures)**

Reference Books

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7thEdn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Higher Enginering Mathematics, B. S. Grewal, Khanna Publisher.
5. Vector Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outlines Series
6. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
7. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
8. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
9. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
10. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
11. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press.
12. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.

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Paper Code: UG-PHS-MI-P-201
Topic name: Mathematical Physics-I (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Practicals:

1. Introduction and Overview

Computer architecture and organization, memory and Input/output devices.

2. Basics of scientific computing

inary 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.

3. Errors and error Analysis.

Truncation and round of errors, Absolute and relative errors, Floating point computations.

4. Introduction to plotting graphs with Gnuplot / QtiPlot (or some other GUI based free software like Grace, Origin etc.)

Basic 2D graph plotting – plotting functions and data files, fitting data using gnuplot'sfit function, polar and parametric plots, modifying the appearance of graphs, exporting plots.

5. Introduction to programming in python:

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, file handling, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements.

6. Programs

(a) Elementary calculations with different type of data e.g., area and volume of regular shapes using formulae. Creation and handling one dimensional array. Sum and average of a list of numbers stored in array, finding the largest and lowest number from a list, swapping two data in a list, sorting of numbers in an array using bubble sort, insertion sort method. Calculation of term value in a series and finding the other terms with a seed (value of particular term) and calculation

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of different quantities with series. Convergence and accuracy of series. Introduction of three-dimensional array. Simple calculations of matrices e.g., addition, subtraction, multiplication.

(b) Curve fitting, Least square fit, Goodness of fit, standard deviation

(c) Ohms law to calculate R,

(d) Hooke's law to calculate spring constant

Reference Books

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
3. Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
4. Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Huff, 2015, O'Rielly A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

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Paper Code: UG-PHS-MDC-T-201
Topic name: RENEWABLE ENERGY AND ENERGY HARVESTING
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –10]
Theory: 45 Lectures

(All the topics given below will be taught in qualitative approach and with examples as much as possible)

Course Objectives:

- *Develop understanding of various renewable (non-conventional) energy resources and technologies.*
- *Assess the availability, potential, and suitability of renewable energy sources and substitutes for conventional energy resources.*
- *Analyze the environmental impacts and challenges associated with energy use, evaluate solutions for sustainable development.*

Fossil Fuels and Alternate Sources of Energy:

Fossil fuels and nuclear energy, Their limitation, Need of renewable energy, Non-conventional energy sources. An overview of the developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, Solar energy, Biomass, Biochemical conversion, Biogas generation, Geothermal energy, Tidal energy, Hydroelectricity.

(9 Lectures)

Solar energy:

Solar energy and its importance, Storage of solar energy, Solar pond, Non-convective solar pond, Applications of solar pond and solar energy, Solar water heater, Flat plate collector, Solar distillation, Solar cooker, Solar green houses, Solar cell, Absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits and sun tracking systems. **(10 Lectures)**

Wind Energy harvesting:

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces and grid interconnection topologies. **(5 Lectures)**

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Ocean Energy:

Ocean Energy, Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(6 Lectures)**

Geothermal Energy: Geothermal resources, Geothermal technologies. **(4 Lectures)**

Hydro Energy:

Hydropower resources, Hydropower technologies, Environmental impact of hydro power sources. **(5 Lectures)**

Piezoelectric Energy harvesting:

Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectric effect, Piezoelectric parameters and modelling piezoelectric generators, Piezoelectric energy harvesting applications, Human power. **(6 Lectures**)

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

2. Solar energy - M P Agarwal - S Chand and Co. Ltd.

3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.

4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.

5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009

6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

7. http://en.wikipedia.org/wiki/Renewable_energy

8. Snatak Padartha Vigyan, Renewable Energy Sources, A M Rudra, A Bhattacharya and A Dan, The New Book Stall, 2018.

B.Sc. Physics, MU

Paper Code: UG-PHS-SEC-T-201
Topic name: Basic Instrumentation and Their Uses
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –10]
Theory: 45 Lectures

Course Objectives:

The aim of this course is to course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Electrical/ Electronic Instruments:

Unit 1 Voltage and current sources, Principles of measurement of dc voltage & current, ac voltage & current and a resistance, Specifications of an electronic voltmeter/ multi-meter and their significance, Advantages of electronic voltmeter over conventional multi-meter for the measurement of voltage, Instrumental accuracy, Precision, Sensitivity, Resolution, Range *etc*., Errors in measurements and loading effects. **(10 Lectures)**

Unit 2 Cathode Ray Oscilloscope: Block diagram of basic CRO, Time base operation, Synchronization, Front panel controls, Specifications of a CRO and their significance, Use of CRO for the measurement of voltage (dc and ac), frequency, Special feature of dual trace. **(5 Lectures)**

Unit 3 Signal Generators: Block diagram, Explanation and specifications of low frequency signal generators, Pulse generators and function generators. **(5 Lectures)**

Unit 4 Digital Instruments: Principle and function of a digital meter, Characteristics of a digital meter, Comparison of analog& digital instruments. **(5 Lectures)**

Optical Instruments:

Unit 1 Optical microscope: Simple microscope, Compound microscope, Electron microscope: Principal components, Working principle and uses. **(5 Lectures)**

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Unit 2 Telescope: Principal components, Working principle and uses of different types of telescopes (Astronomical telescope, Terrestrial telescope, Reflecting telescope).

(5 Lectures)

Unit 3 An objective lens and an eyepiece or ocular lens: Elements, Angular magnification of a telescope, Angular magnification of a microscope, Huygens eyepiece, Ramsden eyepiece.

(5 Lectures)

Unit 4 Spectrometer: Principal components, Role of individual components, Uses, Ultraviolet-Visible (UV-VIS), Near-infrared (NIR) and Raman spectrometers. **(5 Lectures)**

Reference Books:

1. Modern electronic instrumentation and measurement techniques India, Albert D Helfrick & William D Cooper 1992, Prentice Hall India Learning Private Limited.

2. Basic Electrical and Electronics Engineering, S. K. Bhattacharya, 2011, Pearson Education India.

3. The Theory of Optical Instruments, E T Whittaker, 2023, Mjp Publishers

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NEP curriculum for Semesterized Under-Graduate Course in Physics

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SEMESTER-III

PHYSICS

MURSHIDABAD UNIVERSITY

Paper Code: UG-PHS-M-T-301
Topic name: Waves and Optics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Superposition of Harmonic Oscillation:

Linearity and superposition principle: superposition of two collinear oscillations having equal frequencies (both analytical and vector method) and different frequencies (beats) (graphical representation).

Superposition of two perpendicular Harmonic oscillations: Graphical and analytical method, Lissagious figures and their uses. **(5 Lectures)**

Basics of wave:

Plane and spherical waves, longitudinal and transverse waves, plane progressive waves. Wave equation for travelling waves. Particle and wave velocity. Differential equation, pressure of longitudinal wave, energy transport, intensity of wave. **(5 Lectures)**

Velocity of waves:

Velocity of transverse vibration of a stretched string, standing (stationary) waves in a string, phase and group velocities, plucked and strucked strings. Velocity of longitudinal wave in a fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction , Doppler effect.

(8 Lectures)

Geometrical optics:
Fermat's principle, matrix method, thick lens, aberration: spherical and chromatic. **(4 Lectures)**
Wave optics:
Definition and properties of wavefront, Huygen's principle, temporal and spatial coherence.
(3 Lectures)

Interference:

Division of amplitude and wavefront, Young's double slit experiment , Lloyd's mirror, Fresnel's biprism , phase change on reflection, Stoke's treatment. Interference in thin film,: parallel and weidge shaped films. Fringes of equal inclination, friges of equal thickness. Newton's rings.

(7 Lectures)

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Interferometer:

Michelson Interferometer, determination of wavelength, wave difference, refractive index and visibility of fringes. Fabry-Perot Interferometer and its applications. **(5 Lectures)**

Diffraction:

Fresnel's assumption, Fresnel's half period zone. Explanation of rectilinear propagation of light, zone plate, multiple foci of zone plate. Fresnel's diffraction pattern of a straight edge, a wire and a slit.

Fraunhofer diffraction: single slit, double slit, grating, resolving power of grating , uses of grating to produce monochromatic light. **(8 Lectures)**

Reference Books :

1. A Text Book on Light, B. Ghosh, K.G. Mazumder, Sreedhar Publisher.
2. Advanced Acoustics, D. P. Roychowdhury, Chayan Publishe
3. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw- Hill.
4. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
5. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
6. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
7. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill
8. Undergraduate Physics Companion (Vol-2), S. Pal, 1st edition, Suhrid Prakashani, Kolkata.

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Paper Code: UG-PHS-M-P-301
Topic name: Waves and Optics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Determination of unknown frequency of a tuning fork by Sonometer.
2. To study Lissajious figure.
3. To determine frequency of an electric tuning fork by Melde's experiment and verify X^{2}-T law.
4. To determine r.i of material of a prism using Na-source.
5. To draw deviation-wavelength of the material of a prism and to find wavelength of an unknown line from its deviation.
6. To determine wavelength of Na light using Newton's rings.
7. Determination of width of a single slit producing Fraunhofer diffraction pattern.
8. To study diffraction of light using double slits and determination of unknown wavelength.
9. To determine wavelength of spectral line of Hg vapour using plane diffraction grating.

Reference Books:

1. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. AdvancedPractical Physics, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central BookAgency(P)Limited

4. Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-302
Topic name: Electricity and Magnetism
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

1. Electrostatics: Coulomb's law, Electric field. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic potential, Equipotential surfaces. Calculation of potential for simple cases (e.g.: uniform line charge, disc, spherical shell, sphere etc.). Potential and field due to a physical dipole; Torque, force and Potential Energy of an electric dipole in a uniform electric field.

Electrostatic energy of system of charges, a charged sphere. Conductors in an electrostatic field. Mechanical force on the surface of a charged conductor. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Capacitance for parallel-plate, cylindrical,sphericalcapacitors(withoutdielectrics). **(8 Lectures)**

2. Dielectric properties of matter: Dielectric in an external electric field. Electric Fields inside matter, Electric Polarisation, bound charges, displacement vector, relation between E ,P and D. Gauss's theorem in dielectrics, linear Dielectric medium, electric susceptibility and dielectric constant. Electrostatic boundary conditions for E and D.

(4 Lectures)

3. Laplace's and Poisson equations: Laplace's and Poisson equations. Uniqueness Theorems. Earnshaw's theorem. Dirichlet Boundary value problems in electrostatics.

(2 Lectures)

4. Method of Images and its applications: Earthed plane Infinite metal sheet, Semi-infinite dielectric medium and grounded metal Sphere. **(3 Lectures)**

5. Lorentz force: Force on a moving charge in simultaneous electric and magnetic fields, force on a current carrying conductor in a magnetic field. Trajectory of charged particles in crossed uniform electric and magnetic fields. **(2 Lectures)**

6. Magnetostatics: Biot and Savart's law, magnetic field due to a straight conductor, circular coil, solenoid. Ampere's circuital law with applications (infinite long wire, infinite solenoid, infinite current sheet). Magnetic field due to a small current loop - concept of magnetic dipole. Torque and force on magnetic dipole in a uniform magnetic field. Derivation of $\nabla.B = 0$, $\nabla \times B =$

μ_0J. Magnetic vector potential. Calculation for vector potential in simple cases (i) infinite straight wire (ii) infinite solenoid . **(7 Lectures)**

7. Magnetic properties of matter: (a) Magnetic dipole moment. Force and torque on a magnetic dipole in a uniform magnetic field. (b) Magnetization, bound currents. Magnetic intensity H. Relation between B , H and M. Linear media. Magnetic Susceptibility and Permeability. **(4 Lectures)**

8. Electromagnetic induction: Faraday's law of induction: simple examples (e.g.: Motional EMF, Faraday disc); Lenz's law. Self and mutual inductances in simple cases, energy stored in inductors. **(3 Lectures)**

9. Transients: Growth and decay of currents and voltages in L-R, C-R and L-C-R circuits; electrical oscillations in L-C circuits**.** **(2 Lectures)**

10. Electrical Circuits : AC Circuits: Kirchhoff s laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. **(3 Lectures)**

11. Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. **(4 Lectures)**

12. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. **(3 Lectures)**

Reference Books:

1. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M.Sands, 2008, PearsonEducation.

2. Introduction to Electrodynamics, D.J. Griffiths, 4th Edn., 2015, Pearson Education.

3. Electricity and Magnetism, D.Chattopadhyay and P.C.Rakshit, 2011, New Central Book Agency, 2011.

4. Fundamentals of Electricity and Magnetism, B. Ghosh, 2015, Books and Allied (P) Ltd., 4th edition, 2015.

5. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.

6. Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill

7. Electricity and Magnetism, J.H.Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

8. Fundamentals of Physics Extended, 10th Edition, David Halliday, Robert Resnick, Jearl Walker .

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Paper Code: UG-PHS-M-P-302
Topic name: Electricity and Magnetism (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. To study the characteristics of a series RC Circuit.

2. To study the characteristics of a series LR Circuit.

3. To determine an unknown Low Resistance using Carey Foster's Bridge.

4. Measurement of the resistance of a mirror galvanometer by the half deflection method and to determine its figure of merit.

5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)

6. To verify the Thevenin and Norton theorems.

7. To verify the Superposition, and Maximum power transfer theorems.

8. To determine self inductance of a coil by Anderson's bridge.

9. To study 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.

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

11. Determine a high resistance by leakage method using Ballistic Galvanometer.

Reference Books:

1. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. Advanced Practical Physics, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency(P) Limited

4. Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-T-301
Topic name: Mechanics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial–15]
Theory: 45 Lectures

Course Objectives:

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass (CM), equation of motion of the CM. Principle of conservation of momentum. Impulse. **(5 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. Work done by non-conservative forces. Law of conservation of Energy. **(3 Lectures)**

Rotational Dynamics: Angular velocity & angular momentum of a particle. Torque. Principle of conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Parallel and perpendicular axes theorem and their applications for symmetric bodies **(9 Lectures)**

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. Work done in stretching and work done in twisting a wire. Twisting torque on a Cylinder or Wire. **(3 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Basic idea of Viscosity. Stokes Law (no rigorous derivation). Terminal velocity. Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Equation of continuity. Euler's Equation. Bernoulli's Theorem. **(3 Lectures)**

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant).

B.Sc. Physics, MU

Orbit under inverse square law - Kepler's laws. Brief discussion of motion in a non-inverse square central force field. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts. **(10 Lectures)**

Waves & Oscillations: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. **(6 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. **(6 Lectures)**

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

5. Mechanics through Problems, Dhiranjan Roy, Ananda Dasgupta, 2022, Techno World.

6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

7. A Treatise on General Properties of Matter, H. Chatterjee, R. Sengupta, New Central Book Agency, 2022

8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

9. Mechanics and general properties of matter, Satyendra Nath Maiti and Debiprasad Roychoudhury, New age international.

10. Classical Mechanics, S.L. Gupta, V. Kumar, H.V. Sharma, Pragati Prakashan, 2019

11. Vibrations, Waves and Acoustics, D Chattopadhyay and P C Rakshit, Books and Allied Pvt. Ltd.

12. Advanced Acoustics, D P Roychaudhuri and P Banerjee, The New Book Stall, 2009

13. Introduction to Special Relativity, Robert Resnick, Wiley, 2021

B.Sc. Physics, MU

Paper Code: UG-PHS-MI-P-301
Topic name: Mechanics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Measurements of length, diameter, area of cross-section & volume using slide calipers, screw gauge and travelling microscope.

2. To determine the Moment of Inertia of a Flywheel/ a rigid body.

3. To determine g and velocity for a freely falling body using Digital Timing Technique

4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

5. To determine the Young's Modulus of the material of a bar by flexure method

6. To determine the Modulus of Rigidity of a Wire by Maxwell's needle / dynamical method.

7. To determine the elastic Constants of a wire by Searle's method.

8. To determine the value of g using Bar Pendulum / Kater's Pendulum.

9. To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork

10. Measurement of coefficient of viscosity by Stoke's method.

Reference Books

1. Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House.

2. A Text Book of Practical Physics, I.Prakash& Ramakrishna,11thEdn,2011,KitabMahal.

3. Engineering Practical Physics, S.Panigrahi&B.Mallick,2015,CengageLearningIndiaPvt.Ltd.

4. Practical Physics,G.L.Squires,2015, 4thEdition,CambridgeUniversityPress.

5. Practical Physics, D Chattopadhyay, P C Rakshit and B Saha, Books and Allied Pvt. Ltd.

6. Advanced Practical Physics, B Ghosh and K G Mazumdar, Sreedhar Publishers.

7. B. Sc. Practical Physics, Harnam Singh and P S Heme, S Chand and Company Limited.

8. B. Sc. Practical Physics, C L Arora, S Chand and Company Limited.

B.Sc.-Physics,MU

Paper Code: UG-PHS-MDC-T-301
Topic name: Frontiers in Physics
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –10]
Theory: 45 Lectures

(All the topics given below will be taught in qualitative approach and with examples as much as possible)

Course Objectives:

- To provide an overview of key physics concepts and principles.
- To demonstrate the relevance of physics in everyday life.
- To develop critical thinking skills in analysing and explaining real-world phenomena using physics principles.
- To foster an appreciation for the scientific method and the role of physics in advancing society.

General Properties of Matter:

Elasticity: Hooke's law, Stress-strain relationship, Stress-strain diagram, Basic concepts of elastic moduli and relation between elastic constants, Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants.

Hydrostatics: Pressure due to a fluid column, Equilibrium of two different liquids in a U-tube, Pascal's law and its applications (hydraulic lift and hydraulic brakes).

Hydrodynamics: Viscosity, Streamline and turbulent flow, Critical velocity, Stokes' law, Terminal velocity, Bernoulli's theorem and its applications. Surface energy and surface tension, Factors affecting surface tension of a liquid, Capillarity, Angle of contact, Excess-pressure across a curved surface, Effects of surface tension to drops, bubbles and capillary rise.

(15 Lectures)

Heat:

Thermal Properties of Matter: Heat, Temperature, Temperature scale- Celsius, Fahrenheit, Reaumur and Kelvin, Relation between different temperature scales, Thermal expansion,

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Thermal expansion of solids, Practical applications of thermal expansion of solids. Thermal expansion of liquids, Anomalous expansion of water. Thermal expansion of gasses, Boyle's law, Charles law, Pressure law, Equation of state of an ideal gas, Specific heat capacity, Cp, Cv – Calorimetry, Change of state, Latent heat, Melting point and freezing point, Vaporisation-sublimation, evaporation and effects of different factors on evaporation.

Transmission of Heat: Conduction of heat-variable state, steady state, thermal conductivity, practical examples of conduction of heat. Convection of heat- practical examples of convection of heat. Radiation of heat- Emission and absorption, Greenhouse, Blackbody radiation, Planck's distribution law, Wien's displacement Law, Stefan's law (statements only).

Kinetic Theory of Gases: Equation of state of a perfect gas, Work done in compressing a gas, Kinetic theory of gases: Postulates, Concept of pressure, Kinetic interpretation of temperature, RMS speed of gas molecules, Degrees of freedom, the law of equi-partition of energy (statement only) and its application to specific heat capacities of gases, Concept of mean free path, Avogadro's number. **(22 Lectures)**

Gravitation: Universal law of gravitation, Acceleration due to gravity and its variation with altitude and depth. Gravitational field, gravitational potential and gravitational potential energy, Kepler's laws of planetary motion (statements only), Escape velocity, Artificial satellites- orbital velocity of an artificial satellite, Geo-stationary satellites, Polar satellites, Geosynchronous satellites. **(8 Lectures)**

Reference Books :

1. Thermal Physics, S.Garg, R.Bansal and C.Ghosh,1993,Tata McGraw-Hill.
2. New Simplified Physics, S L Arora, DhanpatRaI& Co. Pvt. Ltd, Vol.1, 2020
3. Concepts of Physics, H C Verma, Vol 1 & 2, Bharati Bhawan.
4. Heat Thermodynamics and Statistical Physics, Brijlal, Subrahmanyam, Heme, S Chand.
5. A Treatise on Heat, Meghnad Saha and B.N.Srivastava, 1969, Indian Press.
6. Thermal Physics, A. B. Gupta, Haripada Roy, Books & Allied Ltd
7. A Treatise on General Properties of Matter, H. Chatterjee, R. Sengupta, New Central Book Agency, 2022

B.Sc.-Physics, MU

Paper Code: UG-PHS-SEC-T-301
Topic name: Nanomaterials and Applications
(Credits: Theory-03)
F. M. = 60 (Theory –45, Internal Assessment –15)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –10]
Theory: 45 Lectures

Course Objectives:

- *Equip students with a comprehensive understanding of nanomaterials, their synthesis, characterization, and applications.*
- *Specifically, it aims to develop a strong foundation in the fundamentals of nanotechnology, covering various aspects like synthesis techniques, properties, and diverse applications.*

NANOSCALE SYSTEMS: Brief overview in nano, nanoscale, Classification of nanostructured materials, Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(10 Lectures)**

SYNTHESIS OF NANOSTRUCTURE MATERIALS: Synthesis processes of nanomaterials (Top down and Bottom up approach), Chemical, Ball milling, thin film processes: Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, Ebeam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spraypyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. **(10 Lectures)**

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy (UV-PL), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Magnetic measurements techniques. **(8 Lectures)**

OPTICAL AND MAGNETIC PROPERTIES: Coulomb interaction in nanostructures, Concept of dielectric constant for nanostructures and charging of nanostructure. magnetic effect in nanoparticles, Excitons in direct and indirect band gap semiconductor nanocrystals. Radiative processes: General formalization absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. Defects and impurities: Deep level and surface defects. **(10 Lectures)**

APPLICATIONS: Applications of magnetic and optical semiconductor nanoparticles, quantum dots, nano wires and thin films for photonic devices (LED, solar cells). CNT based transistors.

B.Sc. Physics, MU

Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS), biomedical applications. **(7 Lectures)**

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

2. Nanomaterials Theory Problems and Solutions, Upendranath Nandi, Debnarayan Jana, Techno World.

3. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)

4. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).

5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

6. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

B.Sc.-Physics, MU

NEP curriculum for Semesterized Under-Graduate Course in Physics

SEMESTER-IV

B.Sc.-Physics, MU

PHYSICS

MURSHIDABAD UNIVERSITY

Paper Code: UG-PHS-M-T-401
Topic name: Mathematical Physics-II
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial–15]
Theory: 45 Lectures

Fourier Series:

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity. **(10 Lectures)**

Frobenius Method and Special Functions

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and Orthogonality.

(16 Lectures)

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(3 Lectures)**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes**.** Diffusion Equation. **(6 Lectures)**

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Variational calculus in physics

Functionals. Basic ideas of functionals. Extremization of action as a basic principle in mechanics. Lagrangianfomulation. Euler's equations of motion for simple systems: harmonics oscillators, simple pendulum, spherical pendulum, coupled oscillators. Cyclic coordinates. Symmetries and conservation laws. Legendre transformations and the Hamiltonian formulation of mechanics. Canonical equations of motion. Applications to simple systems. **(10 Lectures)**

Reference Books :

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Higher Enginering Mathematics, B. S. Grewal, Khanna Publisher.
5. Vector Analysis, S. Lipschutz, D. Spellman, M. R. Spiegel, Schaum's Outlines Series
6. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
7. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning.
8. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
9. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press.
10. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
11. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press.
12. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.

B.Sc-Physics, MU

Paper Code: UG-PHS-M-P-401
Topic name: Mathematical Physics – II (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Introduction to Numerical computation using numpy and scipy.

Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Basic linear algebra using the linalg submodule. Introduction to online graph plotting using matplotlib. Introduction to the scipy module. Uses in optimization and solution of differential equations.

2. Solution of Linear system of equations by Gauss elimination method and Gauss Seidel method.

3. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems (a) Solution of mesh equations of electric circuits (3 meshes) (b) Solution of coupled spring mass systems (3 masses)

4. Generation of Special functions using User defined functions (a) Generating and plotting Legendre Polynomials Generating and plotting Bessel function (Make use of generating function and recursion formula).

5. Root finding: Bisection and Newton-Raphson method.

6. Interpolation by Lagranges method.

7. Numerical differentiation - forward and backward difference formulae.

8. Numerical integration - trapezoidal and simpsons rule.

9. Solution of ODE: First order Differential equation - Euler's method.

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10. Basic 3D graph plotting - plotting functions and data files, parametric plots, Surface and contour plots

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.
3. Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.
4. Effective Computation in Physics- Field guide to research with Python, A. Scopatz and K.D. Huff, 2015, O'Rielly A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition.
6. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T.Pang, 2nd Edn., 2006,Cambridge Univ. Press Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-402
Topic name: Thermal Physics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Kinetic Theory of Gases &Distribution of Velocities: Preliminaries: Basic postulates of kinetic theory. Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **(4 Lectures)**

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian motion and its Significance. **(3 Lectures)**

Real Gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling. **(8 Lectures)**

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. **(6 Lectures)**

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator &coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. (**9 Lectures)**

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Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero. **(5 Lectures)**

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations. (**5 Lectures)**

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell'sRelations such as Cp-Cv, TdS Equations, Joule-Kelvin coefficient for Ideal and Van der WaalGases, Energy equations, Change of Temperature during Adiabatic Process. Isothermal and adiabatic compressibility. **(5 Lectures)**

Reference Books:

1. Thermal Physics, A. B. Gupta, Haripada Roy, Books & Allied Ltd

2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw- Hill.

3. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press

4. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw- Hill

5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

6. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

7. Concepts in Thermal Physics, Blundell and Blundell, 2nd Ed., 2012, Oxford University Press .

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-402
Topic name: Thermal Physics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. To determine the temperature coefficient of resistance using the Carry Foster bridge.

3. Measurement of the coefficient of linear expansion of a solid using an optical lever

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).

6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

7. Determination of the melting point of a solid with a thermocouple.

8. Measurement of the coefficient of linear expansion of a solid using an optical lever.

7.Verification of Stefan-Boltzman law using tungsten bulb.

8. Determination of the boiling point of a liquid by Platinum resistance thermometer

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Pub House

2. Advanced Practical Physics, Vol 1, B. Ghosh, K. G. Majumder, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency (P) Ltd

4. A Text Book of Practical Physics, Indu Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

5. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

6. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.

7. B.Sc. Practical Physics, Harnam Singh, Dr. P.S. Hemne, 2018, S. Chand.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-403
Topic name: Analog Electronics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Semiconductor Fundamentals:

Crystalline solids, semiconductors, electron and hole, intrinsic semiconductor, doping and n-type and p-type semiconductors, direct and indirect band gap semiconductors, effective mass, Fermi level, energy band, distinction of metal, insulator and semiconductors, energy band diagrams ,drift and diffusion of carriers, Einstein relation, continuity equation, resistivity and four-probe technique. **(6 Lectures)**

Semiconductor diodes and applications:

p-type and n-type semiconductors, fabrication of p-n junction diode, barrier potential, forward and reverse biased diode, static and dynamic resistance, junction capacitance, energy band diagram.

Diode rectifiers: half wave, centre –tapped and bridge full wave rectifier, calculation of average, r.m.s current and voltage, voltage regulation, ripple voltage, rectification efficiency, filters.

Zener diode, zener and avalanche breakdown , zener diodes as a voltage regulator, clipping, clamping circuits, principle of LED, solar cell and photodiode. **(8 Lectures)**

Bipolar transistor:

n-p-n and p-n-p transistors, characteristics of CE,CB and CC configuration, active, cutoff and saturation regions, current gain α and β, relation between α and β.

Brief idea of JFET and MOSFET. (**5 Lectures)**

Transistor amplifiers:

Load line, Q-point, transistor biasing and stabilization, fixed bias and voltage divider bias. Two port modeland hybrid(h) parameters, analysisof single stage CE amplifier using hybrid models, currentand voltagegains , input and output impedance.

Transistor power amplifiers: Class A, Class B, Class AB and Class C amplifiers.

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Transistor RC coupled amplifier and its frequency response. **(10 Lectures)**

Feedback:

Concepts of feedback, effectof positiveand negativefeedback on input, output impedance, gain, stability, distortion and noise. **(4 Lectures)**

Oscillator:

Bark-hausen criterion for self sustained oscillations, Hartley, Colpitts , RC phaseshift andcrystal oscillator. **(4 Lectures)**

OP-AMP:

Characteristics of an ideal and practical OP-AMP, IC-741, open and closed loop gain, CMRR, offset current and voltage, slew rate.

Concept of virtual ground, differential amplifier, invertingand non-inverting amplifier, adder, differentiator, integrator, logarithmic amplifier, comparator, zero- crossing detector and smith trigger. **(8 Lectures)**

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Fundamental Principles of Electronics, B Ghosh, 2nd ed, 2008, Books & Allied (P) Ltd.
3. Electronics: Analog and digital, Barun Raychaudhuri, Cambridge University Press.
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning
6. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
7. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hal
8. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
9. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

B.Sc. Physics, MU

Paper Code: UG-PHS-M-P-403
Topic name: Analog Electronics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. To study V-I characteristics of P-N junction diode and determine cut in voltage , static resistance and dynamic resistance.
2. To study V-I characteristicsof azener diode and its use as a voltage regulator.
3. To study characteristics of a bipolar junction transistor in CE configuration.
4. To study characteristics of a bipolar transistor in CB configuration.
5. To study frequency response of voltage gain of a RC coupled transistor amplifier.
6. To design differential amplifier using OP-AMP.
7. To design inverting amplifier using OP-AMP of a given gain and study its frequency response.
8. To design non- inverting amplifierusing OP-AMP of a given gain and study its frequency response.
9. To design differentiator using OP-AMP.
10. To design integrator using OP-AMP.
11. To design Wein- Bridge oscillator using OP-AMP.

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Fundamental Principles of Electronics, B Ghosh, 2nd ed, 2008, Books & Allied (P) Ltd.
3. Electronics: Analog and digital, Barun Raychaudhuri, Cambridge University Press.
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B.G.Streetman&S.K.Banerjee, 6th Edn.,2009, PHI Learning
6. Electronic Devices & circuits, S.Salivahanan&N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
7. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hal.

B.Sc. Physics, MU

Paper Code: UG-PHS-M-T-404
Topic name: Solid State Physics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Crystal Structure:

Solids: amorphous and crystalline materials. Lattice translation vectors, unit cell, Miller Indices, reciprocal lattice, types of lattices. Broullioun zones, diffraction of x-rays by crystals, Bragg's law, atomic and geometric structure factor. **(8 Lectures)**

Elementary Lattice Dynamics:

Lattice vibrations and phonons, linear monatomic and diatomic chains, acoustical and optical phonons, qualitative description of phonon spectrum in solids. Dulong and Petit's law, Einstein – Debye theories of specific heat of solids,T^3 -law. **(8 Lectures)**

Magnetic properties of matter:

Dia, para and ferromagnetic materials. Classical Langevin theory of dia and paramagnetic materials. Curie's law, Weiss's theoryof ferromagnetism and ferromagnetic domains. Hysteresis loop and energyloss. **(6 Lectures)**

Dielectric property of materials:

Polarization, local electric field of an atom, depolarization field, electric susceptibility, polarizability, Clausius-Mosotti equation. Classical theory of electricpolarizibility. Frequency dependence of dielectric constant. Langevin-Debye equation. **(6 Lectures)**

Ferroelectric properties of materials:

Piezoeletric effect, pyroelectric effect, ferroelectric effect, electrostrictive effect, Curie-Weiss law, ferroelectric domins, ferroelectric domains, PE hysteresis loop. **(5 Lectures)**

Band theory:

Bloch's theorem, energy bands in solids, Kronig-Penny model, band gap, conductor, Semiconductor, insulator. Conductivity of semiconductor, mobility, Hall effect.

(6 Lectures)

B.Sc.-Physics, MU

Superconductivity:

Critical temperature, critical magnetic field, Meissner effect, type–I and type-II superconductivity, London equation and penetration depth, isotope effect, idea of BCS theory.

(6 Lectures)

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Pvt Ltd.
2. Solid State Physics, S.O Pillai, New Age International Private Limited.
3. Solid State Pahysics, A.J Dekker, Laksmi Publication.
4. Essentials of Solid State Physics, S.P Kulia, NCBA
5. Elements of Solid State Physics, J.P Srivastava, Prentice Hall of India
6. Solid State Physics, M.A Wahab, Narosa Publications
7. Introduction to Solids, Leonid V. Azaroff,Tata Mc-Graw Hill
8. Solid State Physics, R.K Puri and Babbar, S.Chand and Company Ltd.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-404
Topic name: Solid State Physics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Determination of resistivity and band gap of a semiconductor by four probe method.
2. Determination of Hall coefficient of a semiconductor sample.
3. To measure hysteresis loop (P-E) of ferroelectric crystal and find coercive field.
4. To draw B-H curve of Fe using solenoid and determine energy loss from hysteresis.
5. To measure dielectric constant of a soid.
6. Determination of horizontal component of earth's magnetic field by deflection and oscillation magnetometer.
7. To determine coupling coefficient of piezoelectric crystal.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, Wiley India Pvt Ltd.
2. Solid State Physics, S.O Pillai, New Age International Private Limited.
3. Solid State Pahysics, A.J Dekker, Laksmi Publication
4. Essentials of Solid State Physics, S.P Kulia, NCBA
5. Elements of Solid State Physics, J.P Srivastava, Prentice Hall of India

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-T-401
Topic name: Mechanics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass (CM), equation of motion of the CM. Principle of conservation of momentum. Impulse. **(5 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. Work done by non-conservative forces. Law of conservation of Energy. **(3 Lectures)**

Rotational Dynamics: Angular velocity & angular momentum of a particle. Torque. Principle of conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Parallel and perpendicular axes theorem and their applications for symmetric bodies **(9 Lectures)**

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. Work done in stretching and work done in twisting a wire. Twisting torque on a Cylinder or Wire. **(3 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Basic idea of Viscosity. Stokes Law (no rigorous derivation). Terminal velocity. Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Equation of continuity. Euler's Equation. Bernoulli's Theorem. **(3 Lectures)**

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Orbit under inverse square law - Kepler's laws. Brief discussion of motion in a non-inverse square central force field. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts. **(10 Lectures)**

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Waves & Oscillations: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. **(6 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. **(6 Lectures)**

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

3. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

5. Mechanics through Problems, Dhiranjan Roy, Ananda Dasgupta, 2022, Techno World.

6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

7. A Treatise on General Properties of Matter, H. Chatterjee, R. Sengupta, New Central Book Agency, 2022

8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

9. Mechanics and general properties of matter, Satyendra Nath Maiti and Debiprasad Roychoudhury, New age international.

10. Classical Mechanics, S.L. Gupta, V. Kumar, H.V. Sharma, Pragati Prakashan, 2019

11. Vibrations, Waves and Acoustics, D Chattopadhyay and P C Rakshit, Books and Allied Pvt. Ltd.

12. Advanced Acoustics, D P Roychaudhuri and P Banerjee, The New Book Stall, 2009

13. Introduction to Special Relativity, Robert Resnick, Wiley, 2021.

14. Undergraduate Physics Companion (Vol-1), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata.

B.Sc. Physics, MU

Paper Code: UG-PHS-MI-P-401
Topic name: Mechanics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Measurements of length, diameter, area of cross-section & volume using slide calipers, screw gauge and travelling microscope.
2. To determine the Moment of Inertia of a Flywheel/ a rigid body.
3. To determine g and velocity for a freely falling body using Digital Timing Technique
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus of the material of a bar by flexure method
6. To determine the Modulus of Rigidity of a Wire by Maxwell's needle / dynamical method.
7. To determine the elastic Constants of a wire by Searle's method.
8. To determine the value of g using Bar Pendulum / Kater's Pendulum.
9. To draw the frequency - resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork
10. Measurement of coefficient of viscosity by Stoke's method.

Reference Books :

1. Advanced Practical Physics for students, B. L. Flint and H.T.Worsnop, 1971, Asia Publishing House.
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna,11thEdn,2011,KitabMahal.
3. Engineering Practical Physics, S.Panigrahi&B.Mallick,2015,CengageLearningIndiaPvt.Ltd.
4. Practical Physics,G.L.Squires,2015, 4thEdition,CambridgeUniversityPress.
5. Practical Physics, D Chattopadhyay, P C Rakshit and B Saha, Books and Allied Pvt. Ltd.
6. Advanced Practical Physics, B Ghosh and K G Mazumdar, Sreedhar Publishers.
7. B. Sc. Practical Physics, Harnam Singh and P S Heme, S Chand and Company Limited.
8. B. Sc. Practical Physics, C L Arora, S Chand and Company Limited.

B.Sc. Physics, MU

NEP curriculum for Semesterized Under-Graduate Course in Physics

SEMESTER-V

B.Sc.-Physics, MU

PHYSICS

MURSHIDABAD UNIVERSITY

Paper Code: UG-PHS-M-T-501
Topic name: Mathematical Physics-III
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. **(25 Lectures)**

Integrals Transforms:

Fourier Transforms:

Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. **(10 Lectures)**

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. **(10 Lectures)**

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S.Fokas&MJ.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
5. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett .

P.G. Physics, MU

Paper Code: UG-PHS-M-P-501
Topic name: Mathematical Physics-III (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

Numerical computation using Python/MATLAB/Octave/Fortran/C/C++:

1. Dirac delta function: Calculate the integration $\int e^{\frac{-(2-x)^2}{2\sigma^2}}(x+3)dx$ for σ=1, .1, .01 and show it tends to 5.

2. Write a program to calculate the sum $\sum_{n=1}^{\infty} 0.2^n = 1$

3. Evaluate the Fourier coefficients of a given periodic function (square wave).

4. Frobenius method and special functions: Verify the relation $\int_{-1}^{1} P_n(x)P_m(x)dx = \delta_{n,m}$. Plot (x), (x).

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. *sin 6.*

8. Given Bessel's function at N points find its value at an intermediate point.

9. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

10. Compute the nth roots of unity for n = 2, 3, and 4.

11. Find the two square roots of -5+12j.

12. Integral transform: FFT of *exp(-x).*

B.Sc.-Physics, MU

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
3. Complex Variables, A.S.Fokas&MJ.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
4. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
5. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-502
Topic name: Modern Physics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

1. Basics of Quantum Mechanics: Black body Radiation, Planck's quantum hypothesis, Planck's constant (derivation of Planck formula is not required). Photoelectric effect and Compton scattering. De Broglie wavelength and matter waves. Davisson-Germer experiment. Wave-particle duality. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-slit experiment with electrons. Linear superposition principle as a consequence. Heisenberg uncertaintyprinciple (Statement with illustrations). Impossibility of a trajectory of a particle. Dynamical variables as linear hermitian operators and eigenvalue equations, Momentum, energy and angular momentum operators. Measurement of observables, expectation values. Commutation relations between operators. Compatible observables and simultaneous measurements, Ehrenfest theorem. **(15 Lectures)**

2. Schrödinger Equation: Schrödinger equation for non-relativistic particles. Probabilistic interpretation of wave function and equation of continuity (in 1-dimension). Stationary states, Time independent Schrödinger equation as an eigenvalue equation. Probability density and normalization, probability current density in one dimension. **(6 Lectures)**

3. Application to one dimensional systems: Particle in an infinitely rigid box: energy eigenvalues and eigenfunctions, normalization. Step potential, reflection coefficient. Reflection and transmission coefficients for a rectangular barrier in one dimension – explanation of alpha decay Application to one dimensional square well potential of finite depth (for bound states only).

(12 Lectures)

4. Properties and structure of Nucleus: Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Isotopes, isobars, isotones. Nature of nuclear force, Stability and binding, N-Z plot, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. **(8 Lectures)**

5. Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three- Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. **(4 Lectures)**

B.Sc. Physics Mu

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

2. Quantum Mechanics, Bransden and Joachain, Pearson Education Ltd.

3. Feynman Lectures Vol.3, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.

4. Introduction to Quantum Mechanics, David J. Griffiths, 2018, Cambridge University Press 5. Quantum Physics, Stephen Gasiorowicz, 2007, John Wiley & Sons, Inc.

6. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill.

7. Schaum's outline, Theory and Problems of Modern Physics, R. Gautreau and W. Savin, 2ndEdn,2020, Tata McGraw-Hill Publishing Co. Ltd.

8. Quantum Physics of Atoms, Molecules,Solids, Nuclei and Particles, Resnick and Eisberg, 2014, Wiley.

9. Basic Quantum Mechanics, A.K.Ghatak , 2004, Macmillan.

10. Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004, Macmillan

11. Modern Atomic and Nuclear Physics, A. B. Gupta, Books & Allied Ltd; 2nd Revised edition.

12. Nuclear and Particle Physics, S. Bhattacharyya, 2020, Universities Press .

13. Introduction to Elementary Particles, D. Griffiths, 2008, John Wiley & Sons

14. Nuclear Physics, Irving Kaplan, 2002, Narosa

15. Nuclear Physics, An Introduction, S.B. Patel, 2018, New Age International.

16. University Physics With Modern Physics, 14th Edition, By Pearson,, Young Hugh D., Freedman Roger A.

17. Concepts of Modern Physics: Special Indian Edition , Arthur Beiser.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-502
Topic name: Modern Physics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Measurement of Plank constant using LED.

2. Determination of e/m of electrons by using bar magnet.

3. To study the photoelectric effect: variation of photocurrent versus intensity and wavelength of light.

4. To show the tunneling effect in tunnel diode using I −V characteristics.

5. To study the diffraction pattern of a grating with the help of a LASER source and to determine its wavelength.

6. To determine work function of material of filament of directly heated vacuum diode.

7. To determine the ionization potential of mercury.

8. To determine the slit width (a) using diffraction of single slit.

9. To determine the slit width (a,b) using diffraction of double slits.

10. To draw the I-V characteristics of a valve diode and to verify the laws of thermionic emission.

Reference Books:

1. B.Sc. Practical Physics, C.L. Arora, 2010, S. Chand And Company Limited

2. Practical Physics Vol 1 and Vol 2, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publishers

3. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

4. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

5. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-503
Topic name: Quantum and Atomic Physics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Unit – I

General discussion of bound states in an arbitrary potential: Continuity of wave function, boundary conditions and emergence of discrete energy levels. Application to energy eigenstates for a particle in a finite square potential well, Momentum space wavefunction, Time evolution of Gaussian Wave packet, Superposition Principle, linearity of Schrodinger Equation, General solution as a linear combination of discrete stationary states, Observables as operators, Commutator of position and momentum operators, Ehrenfest's theorem. **(8 Lectures)**

Unit – II

Harmonic oscillator: Energy eigen values and eigen states of a 1-D harmonic oscillator using algebraic method (ladder operators) and using Hermite polynomials. Zero point energy and uncertainty principle. **(7 Lectures)**

Unit – III

Schrödinger Equation in three dimensions: Probability and probability densities in 3D. Schrödinger equation in spherical polar coordinates, its solution for Hydrogen atom solution using separation of angular and radial variables, Angular momentum operator, quantum numbers and spherical harmonics. Radial wave functions from Frobenius method; shapes of the probability densities for ground and first excited states; Orbital angular momentum quantum numbers l and m l, s, p, d shells. **(15 Lectures)**

Unit – IV - Atomic Physics

One-electron atoms: Degeneracy of energy levels and selection rules, modes of relaxation of an excited atomic state. Fine structure of Hydrogenic atoms: Shifting of energy levels, Splitting of spectral lines, relativistic correction to kinetic energy, spin-orbit term, Darwin term, fine structure spectral lines, Lamb shift (qualitative idea). Atoms in external magnetic fields: Larmor's theorem, Stern-Gerlach experiment, normal Zeeman Effect, Paschen Back effect, anomalous Zeeman effect, Lande g-factor. **(15 Lectures)**

B.Sc. Physics, MU

References:

1) Quantum Mechanics: Theory and Applications, A. Ghatak and S. Lokanathan, 6th edition, 2019, Laxmi Publications, New Delhi.

2) Introduction to Quantum Mechanics, D. J. Griffith, 2nd edition, 2005, Pearson Education.

3) A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2 nd edition, 2010, McGraw Hill.

4) Quantum Mechanics, B. H. Bransden and C. J. Joachain, 2 nd edition, 2000, Prentice Hall

5) Quantum Mechanics: Concepts and Applications, 2nd edition, N. Zettili, A John Wiley and Sons, Ltd., Publication

6) Physics of Atoms and Molecules, B. H. Bransden and C. J. Jochain, 2nd edition, Pearson

7) Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, 1994, Tata McGraw – Hill

8) Atomic physics, J. B. Rajam and foreword by Louis De Broglie, 2010, S. Chand & Co.

9) Atoms, Molecules and Photons, W. Demtroder, 2nd edition, 2010, Springer

10) Introduction to Spectroscopy, D. L. Pavia, G. M. Lampman, G. A. Kriz and J. R. Vyvyan, 5th edition, 2014, Brookes/Cole

11) Concept of Nuclear Physics, B. L. Cohen, 2003, Tata McGraw – Hill

12) Nuclear Physics, S. N. Ghoshal, 1st edition, 2019, S. Chand Publication

13) Introducing Nuclear Physics, K. S. Krane, 2008, Wiley India.

14) Concepts of Modern Physics: Special Indian Edition (Old Edition), Arthur Beiser.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-503
Topic name: Quantum and Atomic Physics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

Use Fortan/Python/Matlab/Octave/ C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$\frac{d^2y}{dt^2} = \frac{2m}{\hbar^2}\big(E - V(r)\big)y$ where $V(r) = -\frac{e^2}{r}$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is = -13.6 eV. Take e = 3.795 $(\text{eVA})^{1/2}$, he = 1973 (eVA) and m = 0.511 × 10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$\frac{d^2y}{dt^2} = \frac{2m}{\hbar^2}\big(E - V(r)\big)y$ where $V(r) = -\frac{e^2}{r}e^{-r/a_0}$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(\text{eVA})^{1/2}$, m = 0.511 × 10^6 eV/c^2, and a = 3 A, 5A, 7 A. In these units he = 1973(eVA). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$\frac{d^2y}{dt^2} = \frac{2m}{\hbar^2}\big(E - V(r)\big)y$ where $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}kr^2$

Convert to dimensionless variables. Plot the Ground and first exited state wave functions.

4. Solve the s-wave radial Schrodinger equation for the vibration of hydrogen molecule:

$\frac{d^2y}{dt^2} = \frac{2m}{\hbar^2}\big(E - V(r)\big)y$ where $V(r) = D\big(e^{-2\alpha r'} - e^{-\alpha r'}\big)$ and $r' = (r - r_0)/r$

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Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take m =940×10^6 eV/c, D=0.755501 eV, α=1.44, r_0=0.131349 A.

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.

6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting.

7. To show the tunneling effect in tunnel diode using I-V characteristics.

8. Quantum efficiency of CCD's.

Reference Books:

1. Schaum's outline of Programming with C++. J.Hubbard, 2 0 0 0, McGraw-Hill Publication .
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3 rd Edn., 2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press.
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernandez.2014 Springer.
5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
6. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

B.Sc. Physics, MU

Paper Code: UG-PHS-M-T-504
Topic name: Digital Electronics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Introduction to CRO:

Block diagram of CRO, electron gun, deflection system, time base deflection sensitivity. Application of CRO: (i) study of waveform, (ii) measurement of voltage, current, frequency and phase difference **(4 Lectures)**

Number Systems:

Binary numbers, decimal to binary and reverse conversion, binary addition and subtraction (1's complement and 2's complement method), BCD, octal and hexadecimal numbers, representation of negative numbers. **(4 Lectures)**

Digital Circuits:

OR,AND, NOT, NAND, X-OR, X-NOR gates. Realization of OR,AND,NOT gates using diodes and transistor. De- Morgan's theorem, simplification of circuit using Boolean Algebra. SOP,POS, Minterm, Maxterm, simplification of logical expression using SOP, POS method and Karnaugh map(4 variables). **(8 Lectures)**

Combinational Logic Circuit:

Arithmatic and logic circuit:

Half adder, full adder, half and full subtractor, adder-subtractor, digital comparator.**(4 Lectures)**

Data Processing Circuit:

Multiplexer, de multiplexer, decoder, encoder, parity checker. **(4 Lectures)**

Sequential Logic Circuit:

Flip-flop:

RS flip flop, D flip flop, T flip flop, JK flipflop, level and edge triggering, preset and clear operation, master- slave J K flipflop. **(4 Lectures)**

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Shift Register:

Serial in serial out, serial in parallel out, parallel in, serial out , parallel in parallel out shift registor**.** **(3 Lectures)**

Counter:

Synchronous, asynchronous, ripple, decade and ring counter.

Timer: IC-555 block diagram and applications. **(4 Lectures)**

Data Conversion:

D/A (Ladder and weighted resistor) and A/D converter. **(3 Lectures)**

Computer Organization:

Input/Output, ROM-RAM, Computer memory, Memory organization and addressing, memory interfacing. **(2 Lectures)**

Intel 8085 microprocessor:

Block diagram, components, buses, registers, ALU, memory, stack memory, timing status, instruction cycle.

Classification of 8085 instructions,1- byte, 2- byte, 3- byte instructions, simple programmes.

(5 Lectures)

Reference Books:

1. Electronics: Fundamentals and Applications, D. Chattopadhyay, P.C. Rakshit, New Age Publication
2. Fundamental Principles of Electronics, B Ghosh, 2nd ed, 2008, Books & Allied (P) Ltd.
3. Fundamentals of Microprocessor and Microcontrollers, B. Ram, Dhanpat Rai Publications.
4. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
5. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
6. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
7. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
8. Logic circuit design, Shimon P. Vingron, 2012, Springer.
9. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
10. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Gaonkar, Prentice Hall.

B.Sc. Physics, MU

Paper Code: UG-PHS-M-P-504
Topic name: Digital Electronics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. To measure voltage and time period of a periodic waveform using CRO.
2. Construct OR, AND, NOT gates using diode and transistor.
3. Construct OR,AND, NOT and X-OR gates using NAND gates.
4. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
5. Construct half adder and full adder.
6. Construct half subtractor and full subtructor.
7. Construct the 4x1 multiplexer using basic gates and IC 74151.
8. To build RS and D flip-flop using NAND gates.
9. To build JK flipflop using NAND gates.
10. Fabricate a 4 bit counter using FLIP-FLOP IC-s and study its timing diagram.
11. Fabricate a 4-bit shift register using Flip-flop ICs and to study their performance.

Reference Books:

1. Electronics: Fundamentals and Applications, D. Chattopadhyay, P.C. Rakshit, New Age Publication
2. Fundamental Principles of Electronics, B Ghosh, 2nd ed, 2008, Books & Allied (P) Ltd.
3. Fundamentals of Microprocessor and Microcontrollers, B. Ram, Dhanpat Rai Publications.
4. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
5. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
6. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-T-501
Topic name: Waves and Optics
(Credits: 04; Theory-03, Practical- 01)
F. M. = 60 (Theory –40, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 45 Lectures

Course Objectives:

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Superposition of Harmonic Oscillation:

Linearity and superposition principle: superposition of two collinear oscillations having equal frequencies (both analytical and vector method) and different frequencies (beats) (graphical representation).

Superposition of two perpendicular Harmonic oscillations: Graphical and analytical method, Lissagious figures and their uses. **(5 Lectures)**

Basics of wave:

Plane and spherical waves, longitudinal and transverse waves, plane progressive waves. Wave equation for travelling waves. Particle and wave velocity. differential equation. **(5 Lectures)**

Velocity of waves:

Velocity of transverse vibration of a stretched string, standing (stationary) waves in a string, phase and group velocities. Velocity of longitudinal wave in a fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction , Doppler effect. **(8 Lectures)**

Wave optics:

Electromagnetic nature of light wave, definition and properties of wavefront, Huygen's principle. **(3 Lectures)**

Interference:

Division of amplitude and wavefront, Young's double slit experiment , Lloyd's mirror, Fresnel's biprism , phase change on reflection, Stoke's treatment. Interference in thin film,: parallel and weidge shaped films. Fringes of equal inclination, friges of equal thickness. Newton's rings.

(7 Lectures)

Interferometer:

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Michelson Interferometer, determination of wavelength, wave difference, refractive index and visibility of fringes. **(4 Lectures)**

Diffraction:

Fresnel's assumption, Fresnel's half period zone. Explanation of rectilinear propagation of light, zone plate, multiple foci of zone plate. Fresnel's diffraction pattern of a straight edge, a wire and a slit.

Fraunhofer diffraction: single slit, double slit, grating, resolving power of grating. **(8 Lectures)**

Polarization:

Plane polarized light --- production and analysis, double refraction, circular and elliptically polarized light. **(5 Lectures)**

Reference Books:

1. A Text Book on Light, B. Ghosh, K.G. Mazumder, Sreedhar Publisher.

2. Advanced Acoustics, D. P. Roychowdhury, Chayan Publisher

3. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw- Hill.

4. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill

5. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

6. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

7. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill

8. Undergraduate Physics Companion (Vol-2), S. Pal, 1st edition, Suhrid Prakashani, Kolkata.

9. Undergraduate Physics Companion (Vol-2), S. Pal, 1st edition 2022, Suhrid Prakashani, Kolkata.

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-P-501
Topic name: Waves and Optics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Determination of unknown frequency of a tuning fork by Sonometer.
2. To study Lissajious figure.
3. To determine frequency of an electric tuning fork by Melde's experiment and verify X^{2}-T law.
4. Familiarization with Schuster's focusing : determination of angle of prism.
5. To determine r.i of material of a prism using Na-source.
6. To draw deviation-wavelength of the material of a prism and to find wavelength of an unknown line from its deviation.
7. To determine wavelength of Na light using Newton's rings.
8. Determination of width of a single slitproducing Fraunhofer diffraction pattern.
9. To determine wavelength of spectral line of Hg vapour using plane diffraction grating.

Reference Books:

1. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. AdvancedPractical Physics, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central BookAgency(P)Limited

4. Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal

B.Sc.-Physics, MU

NEP curriculum for Semesterized Under-Graduate Course in Physics

SEMESTER-VI

B.Sc.-Physics, MU

PHYSICS

MURSHIDABAD UNIVERSITY

Paper Code: UG-PHS-M(DSE)-T-601
Topic name: Nuclear and Particle Physics
(Credits: Theory-04)
F. M. = 80 (Theory –60, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 60 Lectures

Course Objectives:

- *Subject specific electives allow students to deepen their knowledge in their chosen discipline or explore specialized topics within it.*
- *To familiarize students with advanced concepts, theories or tools specific to the discipline.*
- *To develop analytical, critical thinking, and problem-solving abilities in context with subject.*

General Properties of Nuclei: General ideas about nuclei and their intrinsic properties, idea about nuclear mass, radii, charge density (matter density), binding energy, nuclear forces, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, Spin-parity, magnetic moment, electric moments, nuclear excites states. **(10 Lectures)**

Nuclear Models: Concept of liquid drop model, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, **(10 Lectures)**

Radioactivity: Radioactive decay law, half-life, theory of successive radioactive transformations, radioactive series, α-decay, range of α-particles, Geiger-Nuttal law and a-particle Spectra, Gamow Theory of Alpha Decay, β-decay, energy spectra and neutrino hypothesis, γ-decay, Origin of γ-rays, Nuclear Isomerism and internal conversion. **(7 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q value, reaction rate, reaction cross section, Concept of compound and direct Reactions, resonance reactions, Principle of S. N. Ghoshal's experiment for verification of compound nuclear hypothesis. **(4 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction with matter, photoelectric effect, Compton scattering, pair production. **(4 Lectures)**

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Detectors of Nuclear Radiations: Interaction of Energetic particles with matter, ionization chamber, Gas detectors, GM Counter, Cloud Chambers, Wilson Cloud Chamber, Bubble chamber, Scintillation Detectors, Semiconductor Detectors (Qualitative Discussion Only), construction of photo- multiplier tube (PMT), neutron detector. **(6 Lectures)**

Particle Accelerators: Van-de Graaff Generator, Linear Accelerator, Cyclotron, Betatron, and Light and Heavy Ion Synchro-Cyclotron, idea of Large Hadron Collider. **(5 Lectures)**

Cosmic rays: Nature, origin and properties of cosmic rays, experimental studies. **(4 Lectures)**

Particle Physics: Fundamental particles and their families, fundamental particle-interactions and their basic features, symmetries and conservation laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, Quark model, colour quantum number and gluons, Quark structure of hadrons. **(10 Lectures)**

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen.(Tata Mcgraw Hill, 1998).
3. Nuclear Physics, Irving Kaplan, Narosa Publishing House
4. Nuclear Physics, S. N. Ghoshal, S. Chand and Co. Ltd.
5. Introduction to the physics of nuclei & particles, R.A. Dunlap.(Thomson Asia, 2004).
6. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
7. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
8. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
9. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
10. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
11. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
12. Theoretical Nuclear Physics, J.M. Blatt &V. F.Weisskopf (Dover Pub.Inc., 1991) 97,
13. Introduction to Nuclear and Particle Physics, A. Das and T. Ferbel, World Scientific
14. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)

B.Sc. Physics, MU

Paper Code: UG-PHS-M(DSE)-T-602
Topic name: Classical Dynamics
(Credits: Theory-04)
F. M. = 80 (Theory –60, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial) –15]
Theory: 60 Lectures

Course Objectives:

- *Subject specific electives allow students to deepen their knowledge in their chosen discipline or explore specialized topics within it.*
- *To familiarize students with advanced concepts, theories or tools specific to the discipline.*
- *To develop analytical, critical thinking, and problem-solving abilities in context with subject.*

Lagrangian Mechanics:

Constraints and their classifications with examples, Inconvenience of Newtonian formulation in practice, The principle of virtual work, D'Alambert's principle, generalized coordinates and momenta, Lagrangian function, Lagrange's equations of motion, advantages of Lagrangian formulation over Newtonian one, Cyclic Coordinates, Hamilton's variational principle, Applications of Lagrangian formulation to simple systems. **(15 Lectures)**

Hamiltonian Formulation:

Hamiltonian function and its physical significance, Hamilton's canonical equations of motion, Advantages of Hamiton's formalism over the Lagrangian formulation, Conservation of Energy, Applications of Hamilton's equations to simple systems, Poisson brackets, Canonical transformations, Generating functions. **(15 Lectures)**

Rigid Body Dynamics:

Generalized coordinates of rigid body, body and space reference systems, Angular momentum and moment of inertia tensor of simple rigid body (e.g. cube, sphere, cylinder), Principle axes and principle moments of inertia, Kinetic energy of a rigid body, Euler equations of motion of rigid body. **(10 Lectures)**

Special Theory of Relativity:

Michelson-Morley experiment and its outcome, Two events in two different inertial frames and its correspondence, Simultaneity and order of events, Postulates of special theory of relativity,

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Lorentz transformations, Length contraction, Time dilation, Twin paradox, Proper time and Proper length Relativistic transformation of velocity and frequency, Time like, space like and light like intervals, Causality, Velocity addition theorem, Variation of mass with velocity, particles and Mass-energy equivalence.

Four vector formalism, Minkowski diagram**,** The four velocity, Four acceleration, Four momentum, conservation of four momentum, Energy conservation. Relativistic Doppler effect, Longitudinal and transverse Doppler effect and aberration proceses, Transformation of E and B fields, Invariance of Maxwell equations. **(15 Lectures)**

Reference Books

1.Classical Mechanics, H. Goldstein, C. P. Poole, J. L. Safko, 3rd Edn. 2002, Pearson Education.

2.Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.

3. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.

4 Solved Problems in classical Mechanics, O. L. Delange and J. Pierrus, 2010, Oxford Press.

5. Classical Mechanics: A Course of Lectures. A.K. Raychaudhuri, 1983, Oxford University Press.

6. Classical Mechanics, P. S. Joag, N.C. Rana, , McGraw Hill

7. Introduction to Classical Mechanics With Problems and Solutions , D. Morin, 2008, Cambridge University Press.

8. The special theory of relativity, Sriranjan Banerji, Asit Banerjee, PHI.

9. Fundamentals of Special and General Relativity, K D Krori, PHI.

B.Sc. Physics, MU

Paper Code: UG-PHS-M-T-603
Topic name: Statistical Mechanics
(Credits: Theory-04)
F. M. = 80 (Theory –60, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 60 Lectures

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble: microcanonical, canonical, grand canonical, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) - Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(13 Lectures)**

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. **(5 Lectures)**

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(4 Lectures)**

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(10 Lectures)**

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

(13 Lectures)

B.Sc. Physics, MU

Reference Books:

1. An Introductory Course of Statistical Mechanics, Palash Baran Pal, Narosa.

2. Introduction to Statistical Mechanics, S. K. Sinha, Narosa.

3. Statistical Mechanics, Upendranath Nandi, Techno World.

4. Statistical Mechanics, 2ed, (An Indian Adaptation), K. Huang Wiley India Pvt Ltd.

5. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

6. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

7. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall

8. Introduction to Statistical Physics, K. Huang, 2010, CRC Press

9. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer

10. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

11. Fundamentals of Statistical Mechanics, B. B. Laud, 2020, New Age International Publishers.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-603
Topic name: Statistical Mechanics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Practicals:

Use C/C++/Scilab/Fortan/Python/Matlab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.

2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases

3. Plot Maxwell-Boltzmann distribution function for different temperatures.

4. Plot Fermi-Dirac distribution function for different temperature.

5. Plot Bose-Einstein distribution function for different temperatures.

6. Verification of Stirling approximation for large numbers

Reference Books:

1. Elementary Numerical Analysis, K.E.Atkinson, 3 rdEdn. 2007, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernandez. 2014 Springer ISBN: 978-3319067896
6. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
7. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-T-604
Topic name: Electromagnetic Theory
(Credits: Theory-04)
F. M. = 80 (Theory –60, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 60 Lectures

Review of Maxwell's equation:
Coulomb gauge and Lorentz gauge; Poynting's theorem and Poynting's vector; electromagnetic (em) energy density; physical concept of electromagnetic field energy density. **(6 Lectures)**
EM wave propagation in unbounded media:
Plane em waves through vacuum and isotropic dielectric medium: transverse nature, refractive index, dielectric constant, wave impedance. Plane em waves through conducting medium: relaxation time, skin depth, attenuation constant; Wave propagation through dilute plasma: electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth.
(12 Lectures)

EM waves in bounded media:
Boundary conditions at a plane interface between two media; reflection and refraction of plane em waves at plane interface between two dielectric media -Laws of reflection and refraction; Fresnel's formulae for perpendicular and parallel polarization, Brewster's law; reflection and transmission coefficients; total internal reflection, evanescent waves; metallic reflection (normal incidence). **(10 Lectures)**

Polarization of EM waves:
Propagation of e. m waves in an anisotropic media, uniaxial and biaxial crystal,double refraction,polarization by double refraction, Nicol prism, ordinary and extraordinary refractive indices, circular and elliptically polarized light. Phase retardation plates: quarter wave and half wave plates. Babinet's compensator and its uses.
Optical rotation: Biot's laws for rotatory polarization; Fresnel's theory of optical rotation; specific rotation, Laurent's halfshade polarimeter. **(10 Lectures)**

Wave guides:

Planar optical wave guides; planar dielectric wave guide ($-d/2 < x < d/2$); condition of continuity at interface; phase shift on total reflection; Eigenvalue equations; phase and group velocity of guided waves; field energy and power transmission (TE mode only).

Optical fibers: numerical aperture, step and graded indices, single and multimode fibers (concept and definition only). **(7 Lectures)**

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Reference Books:

1) Introduction to Electrodynamics, D. J. Griffiths, 3rd edition, 1998, Benjamin Cummings.

2) Electromagnetic Field and Waves, P. Lorrain and D. Corson, 2 nd edition, 2003, CBS Publisher

3) Classical Electrodynamics, J. D. Jackson, 3rd edition, 2010, Wiley

4) Principle of Optics, M. Born and E. Wolf, 6th edition, 1980, Pergamon Press

5) Optics, A. Ghatak, 6th edition, 2017, McGraw-Hill Education, New Delhi

6) Electricity, Magnetism and Electromagnetic Theory, S. Mahajan, and S. R. Choudhary, 2017, TMH

7) Principles of Electromagnetic Theory, C. Jain, 2017, Narosa Publishing House

8) Elements of Electromagnetics, M. N. O. Sadiku, 2001, Oxford University Press.

9) Fundamentals of Electromagnetics, M. A. W. Miah, 1982, Tata McGraw Hill

10) Problems and solution in Electromagnetics, A. Ghatak, K. Thyagarajan and Ravi Varshney, 2015.

B.Sc.-Physics, MU

Paper Code: UG-PHS-M-P-604
Topic name: Electromagnetic Theory (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Determination of resistivity and bandgap of a semiconductor by four probe method.
2. Determination of Hall coefficient of a semiconductor sample.
3. To measure hysteresis loop (P-E) of a ferroelectric crystal and find coersive field.
4. To draw B-H curve of Fe using solenoid and determine energy loss from hysteresis.
5. To measure dielectric constant of a solid.
6. Determination of horizontal component of earth's magnetic field by deflection and oscillation magnetometer.
7. To determine coupling co-efficient of piezoelectric crystal.

Reference Books:

1. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. AdvancedPractical Physics, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central BookAgency(P)Limited

4. Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal

B.Sc.-Physics, MU

Paper Code: UG-PHS-MI-T-601
Topic name: Waves and Optics
(Credits: Theory-04)
F. M. = 80 (Theory –60, Internal Assessment –20)
[Internal Assessment: Class Attendance (Theory) – 05, Class Test/ Assignment/ Tutorial –15]
Theory: 60 Lectures

Course Objectives:

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Superposition of Harmonic Oscillation:

Linearity and superposition principle: superposition of two collinear oscillations having equal frequencies (both analytical and vector method) and different frequencies (beats) (graphical representation).

Superposition of two perpendicular Harmonic oscillations: Graphical and analytical method, Lissagious figures and their uses. **(5 Lectures)**

Basics of wave:

Plane and spherical waves, longitudinal and transverse waves, plane progressive waves. Wave equation for travelling waves. Particle and wave velocity. Differential equation, pressure of longitudinal wave ,energy transport, intensity of wave. **(5 Lectures)**

Velocity of waves:

Velocity of transverse vibration of a stretched string, standing (stationary) waves in a string, phase and group velocities, plucked and strucked strings. Velocity of longitudinal wave in a fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction , Doppler effect.

(8 Lectures)

Geometrical optics:

Fermat's principle, matrix method, thick lens, aberration: spherical and chromatic. **(4 Lectures)**

Wave optics:

Definition and properties of wavefront, Huygen's principle, temporal and spatial coherence.

(3 Lectures)

Interference:

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Division of amplitude and wavefront, Young's double slit experiment , Lloyd's mirror, Fresnel's biprism , phase change on reflection, Stoke's treatment. Interference in thin film,: parallel and weidge shaped films. Fringes of equal inclination, friges of equal thickness. Newton's rings.

(7 Lectures)

Interferometer:

Michelson Interferometer, determination of wavelength, wave difference, refractive index and visibility of fringes. Fabry-Perot Interferometer and its applications. **(5 Lectures)**

Diffraction:

Fresnel's assumption, Fresnel's half period zone. Explanation of rectilinear propagation of light, zone plate, multiple foci of zone plate. Fresnel's diffraction pattern of a straight edge, a wire and a slit.

Fraunhofer diffraction: single slit, double slit, grating, resolving power of grating, uses of grating to produce monochromatic light. **(8 Lectures)**

Reference Books :

1. A Text Book on Light, B. Ghosh, K.G. Mazumder, Sreedhar Publisher.
2. Advanced Acoustics, D. P. Roychowdhury, Chayan Publishe
3. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw- Hill.
4. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
5. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
6. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
7. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill
8. Undergraduate Physics Companion (Vol-2), S. Pal, 1st edition, Suhrid Prakashani, Kolkata.

B.Sc. Physics, MU

Paper Code: UG-PHS-MI-P-601
Topic name: Waves and Optics (Practical)
(Credits: Practical- 01)
F. M. = 20 (Practical)
(Laboratory Note Book- 05, Viva-voce- 05, Experiment- 10)

List of Experiments:

1. Determination of unknown frequency of a tuning fork by Sonometer.
2. To study Lissajious figure.
3. To determine frequency of an electric tuning fork by Melde's experiment and verify X^{2}-T law.
4. To determine r.i of material of a prism using Na-source.
5. To draw deviation-wavelength of the material of a prism and to find wavelength of an unknown line from its deviation.
6. To determine wavelength of Na light using Newton's rings.
7. Determination of width of a single slit producing Fraunhofer diffraction pattern.
8. To study diffraction of light using double slits and determination of unknown wavelength.
9. To determine wavelength of spectral line of Hg vapour using plane diffraction grating.

Reference Books:

1. Practical Physics Vol 1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher

2. AdvancedPractical Physics, B. Ghosh, K. G. Majumder, 2023, Sreedhar Publication

3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central BookAgency(P)Limited

4. Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal

B.Sc.-Physics, MU