Sanskaram University, Jhajjar (Haryana)

Curriculum and Syllabi

(Based upon CBCS, LOCF and NEP-2020)

M.Sc. Physics

DEPARTMENT OF PHYSICS

2024-26

Programme Outcomes (POs)

Students enrolled in the Master's Programmes offered by the Departments under the School of Basic Sciences will have the opportunity to learn and master the following components in addition to attain important essential skills and abilities:

PO-No.	Component	Outcomes
PO-1	Basic Knowledge	Capable of delivering basic disciplinary knowledge gained during the programme.
PO-2	In-depth Knowledge	Capable of describing advanced knowledge gained during the programme.
PO-3	Critical thinking and Problem Solving abilities	Capable of analyzing the results critically and applying acquired knowledge to solve the problems.
PO-4	Creativity and innovation	Capable to identify, formulate, investigate and analyze the scientific problems and innovatively to design and create products and solutions to real life problems.
PO-5	Research aptitude and global competency	Ability to develop a research aptitude and apply knowledge to find the solution of burning research problems in the concerned and associated fields at global level.
PO-6	Holistic and multidisciplinary education	Ability to gain knowledge with the holistic and multidisciplinary approach across the fields.
PO-7	Skills enhancement	Learn specific sets of disciplinary or multidisciplinary skills and advanced techniques and apply them for betterment of mankind.
PO-8	Leadership and Teamwork abilities	Ability to learn and work in a group and capable of leading a team even.
PO-9	Environmental and human health awareness	Learn important aspects associated with environmental and human health. Ability to develop eco-friendly technologies.
PO-10	Ethical thinking and Social awareness	Inculcate the professional and ethical attitude and ability to relate with social problems.
PO-11	lifelong learning skills and Entrepreneurship	Ability to learn lifelong learning skills which are important to provide better opportunities and improve quality of life. Capable to establish independent startup/innovation center etc.

Programme Specific Outcomes (PSOs)

The post graduates shall be able to realize the following specific outcomes by the end of program studies:

Number	Programme Specific Outcomes
PSO-1	Identify, formulate, and solve Physics problems
PSO-2	Design and conduct experiments, as well as to analyze and interpret data
PSO-3	Apply knowledge of Physics in a different stream of science and to communicate effectively.
PSO-4	Ability to use the techniques, skills, and modern physical tools in real world application.
PSO-5	Engage in life-long learning and will have recognition.

Structure Of Master's Course

Total Credits of M.Sc. Physics : 96

Types of Courses	Nature	Total Credits	%
Core Courses(DSC)	Compulsory	60	**62.5**
Elective Courses (EC)	Discipline Specific Elective Courses (DSE)	16	**16.7**
	Discipline Specific Skill Based Courses (DSSB)	12	**12.5**
	Generic Elective Courses (GE)	8	**8.3**

Semester-Wise Courses & Credit Distribution

Semester-I

Sr. No.	Course Code	Course Title	L	T	P	Hours / Week	Total Credits
Discipline Specific Core (DSC) Courses							
1	**021301001**	Mathematical Methods in Physics – I (DSC-1)	3	1	0	4	4
2	**021301002**	Classical Mechanics (DSC-2)	3	1	0	4	4
3	**021301003**	Quantum Mechanics – I (DSC-3)	3	1	0	4	4
4	**021301004**	Semiconductor Devices (DSC-4)	3	1	0	4	4
5	**021301005**	Laboratory-I (DSC-5)	0	0	12	12	6
Generic Elective (GE) Courses (for students of Physics Department)							
6	(GE-1) To be opted from another department or from SWAYAM					4	4
Generic Elective (GE) Courses (for students of other Departments)							
7	**021301006**	Modern Optics	3	1	0	4	4
8	**021301007**	Renewable Energy Resources	4	0	0	4	4
							Total Credits - 26

Semester- II

Sr. No.	Course Code	Course Title	L	T	P	Hours / Week	Total Credits
Discipline Specific Core (DSC) Courses							

1	**021302001**	Statistical Mechanics (DSC-6)	3	1	0	4	4
2	**021302002**	Classical Electrodynamics (DSC-7)	3	1	0	4	4
3	**021302003**	Mathematical Methods in Physics-II (DSC-8)	3	1	0	4	4
4	**021302004**	Laboratory II (DSC-9)	0	0	12	12	6
Discipline Specific Elective (DSE) Courses (To be opted any one from the list)							
5	**021302005**	Quantum Mechanics – II (DSE -1)	3	1	0	4	4
6	**021302006**	Introduction to Astronomy and Astrophysics (DSE-2)	3	1	0	4	4
7	**021302007**	Fundamentals of Solar Energy (DSE-3)	3	1	0	4	4
8	**021302008**	Accelerator Physics (DSE-4)	3	1	0	4	4
9	**021302009**	Radiation Physics (DSE-5)	3	1	0	4	4
Generic Elective (GE) Courses (for students of Physics Department)							
10	(GE-2) To be opted from another department or from SWAYAM					4	4
Generic Elective (GE) Courses * (for students of other Departments)							
11	**021302010**	Environmental Physics	3	1	0	4	4
12	**021302011**	Physics of Digital Photography	3	1	0	4	4
							Total Credits - 26

Semester- III

Sr. No.	Course Code	Course Title	L	T	P	Hours / Week	Total Credits
Discipline Specific Core (DSC) Courses							
1	**021303001**	Atomic, Molecular Physics and Lasers (DSC-10)	3	1	0	4	4

2	**021303002**	Nuclear Physics (DSC-11)	3	1	0	4	4
3	**021303003**	Solid State Physics (DSC-12)	3	1	0	4	4
4	**021303004**	Laboratory-III (DSC-13)	0	0	8	8	4
5	**021303005**	Seminar Presentation (DSC-14)	0	2	0	2	2
6	**021303006**	Research and Publication Ethics (DSC-15)	2	0	0	2	2
Discipline Specific Elective (DSE) Courses (To be opted any one from the list)							
7	**021303007**	Physics of Electronic Materials and Devices (DSE-6)	3	1	0	4	4
8	**021303008**	Nuclear Reactor Physics (DSE-7)	3	1	0	4	4
9	**021303009**	Plasma Physics and Fusion Reactor (DSE-8)	3	1	0	4	4
10	**021303010**	Physics of Nanomaterials (DSE-9)	3	1	0	4	4
11	**021303011**	General Theory of Relativity (DSE-10)	3	1	0	4	4
12	**021303012**	Astrophysics of Stars (DSE-11)	3	1	0	4	4
Discipline Specific Skill Based (DSSB) Courses (To be opted any one from the list)							
13	**021303013**	Characterization Techniques for Materials (DSSB-1)	3	0	2	5	4
14	**021303014**	Digital Electronics and Microprocessor (DSSB-2)	3	1	0	4	4
15	**021303015**	Computational Physics (DSSB-3)	3	0	2	5	4
16	**021303016**	Analog Electronics (DSSB-4)	3	1	0	4	4
							Total Credits - 28

Semester- IV

Sr. No.	Course Code	Course Title	L	T	P	Hours / Week	Total Credits

Discipline Specific Core (DSC) Courses							
1	**021304001**	Major Dissertation (DSC-16)	0	0	0	16	16
OR							
2	**021304002**	Major Dissertation (DSC-17)	0	0	0	4	4
Discipline Specific Elective (DSE) Courses (To be opted any two from the list)							
3	**021304003**	Advanced Nuclear Physics (DSE-12)	3	1	0	4	4
4	**021304004**	Particle Physics (DSE-13)	3	1	0	4	4
5	**021304005**	Cosmology (DSE-14)	3	1	0	4	4
6	**021304006**	Ferroelectricity and Magnetism (DSE-15)	3	1	0	4	4
7	**021304007**	Advanced Carbon Materials (DSE-16)	3	1	0	4	4
Discipline Specific Skill Based (DSSB) Courses (To be opted any one from the list)							
8	**021304008**	Experimental Techniques in Nuclear and Particle Physics (DSSB-5)	3	1	0	4	4
9	**021304009**	Astronomy Laboratory (DSSB-6)	3	1	0	4	4
10	**021304010**	Vacuum Science and Thin Film Technology (DSSB-7)	3	1	0	4	4
11	**021304011**	Introduction to Hydrogen Energy Systems (DSSB-9)	3	1	0	4	4
							Total Credits - 16

Note:

- This GE* courses offered by the Department can only be taken by the students of other Departments. The students of the Physics Department will take GE from other Departments.

- The Department may offer more than one discipline specific elective courses (DCE) depending on specialization and strength of faculty members, and the number of students have to opt one of them for semester II. If class strength is less than 10, then that particular subject will not be offered.
- In semester III, students are required to opt two courses out of the listed Discipline Specific Elective Courses and Discipline Specific Skill Based courses. However, a course will be offered subject to the available specialization and strength of the faculty.

- In semester IV, the students have to opt two out of Discipline Specific Elective Courses and one out of Discipline Specific Skill Based courses from various options offered by the Department depending on the specialization and strength of the faculty.

OR

- Student may opt for full semester long dissertation work on the campus or outside the campus in some Laboratories/Institutes/Universities of National Importance.
- For carrying out the dissertation work outside the campus, student will have to produce an invitation/acceptance letter from external supervisor by the end of Semester III.
- Student may complete the dissertation project under the guidance of a supervisor on Sanskaram University campus.
- Student who will pursue the project outside Sanskaram University, will have one internal supervisor and one external supervisor.
- Internal supervisor will periodically interact with student and external supervisor. He/She will be responsible for internal assessment of the candidate from time to time.
- Student will be allowed to work with external supervisor at other outside institutions only after completing all the documentation process at Sanskaram University. Students have to follow the timeline strictly issued by Department from time to time.
- Department will have no financial obligation if student carries out the dissertation work outside Sanskaram University.

<u>Course Structure</u>

Mathematical Methods in Physics I

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject: Mathematical Methods in Physics-I</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester: I
(1st Year)</td><td>Contact Hours per Week: 4</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs: M.Sc. Physics</td><td rowspan="2">Evaluation (Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 Hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: B.Sc.</td></tr>
<tr><td>Course Description</td><td colspan="7">This course has been developed to introduce students to some topics of mathematical Physics which are directly relevant in different papers of Physics course. It includes elements of matrices and group theory, introduction to tensor algebra, function of a complex variable and calculus along with an introduction to computational techniques and statistical measures used in physics Course.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• Learning about matrices and groups
• Understanding basics of Tensors.
• Getting to know the significance of Complex algebra
• Understanding Numerical methods in Physics</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After successful completion of the course the student will be able to do the following :
• To use matrices for solving linear algebraic equations and to use group theory for understanding of crystallography.
• To use tensor transformation and related algebra in physics.
• To solve real definite integrals in theoretical Physics.
• To find roots of a given polynomial and understand the properties of a statistical distribution of point particles.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="6">Content of Each Unit</td><td>Hours of Each Unit</td></tr>
</table>

1	**Matrices and Group Theory :** Linear vector spaces, matrix spaces, linear operators, eigenvectors and eigenvalues, matrix diagonalization, special matrices. Symmetries and groups, multiplication table and representations, permutation group, translation and rotation groups, O(N) and U(N) groups.	15

2	**Tensors Analysis :** Coordinate transformations, scalars, contravariant and covariant vectors, mixed and covariant tensor of second rank, addition, subtraction and contraction of tensors, quotient rule. Christoffel symbols, transformation of Christoffel symbols, Covariant differentiation, Ricci's theorem, divergence, Curl and Laplacian tensor form, Stress and strain tensors, Hook's law in tensor form.	15
3	**Complex Variables :** Functions of complex variable, Limits and continuity, differentiation, Analytical functions, Cauchy-Riemannn conditions, Cauchy Integral theorem, Cauchy integral formula, Derivatives of analytical functions, Liouville's theorem. Power series Taylor's theorem, Laurent's theorem. Calculus of residues–poles, essential singularities and branch points, residue theorem, Jordan's lemma, singularities on contours of integration, evaluation of definite integrals.	15
4	**Computational Techniques and Probability Theory:** Root of functions, interpolation, extrapolation, Integration by trapezoid and Simpson's rule, solution of first order differential equation : using Runge-Kutta method and Finite difference methods. , Preliminary Concepts : mean values, standard deviation, various moments; Random walk problem, Binomial distribution, Poisson distribution, Gaussian distributions, Lorentz distribution, Central Limit Theorem.	15
TEXT BOOKS		

1. **Fredrick W. Byron and Robert W. Fuller**, Mathematics of Classical and Quantum Physics, Dover Publications, Mineola, New York, Vol 1&2, 1970.
2. **Merle C. Potter and Jack Goldberg**, Mathematical Methods, S.CHAND (Prentice Hall of India), New Delhi, 2nd Edition, 1987.
3. **George Arfken and Hans J Weber**, Mathematical Methods for Physicists, Elsevier Academic Press. Cambridge, Massachusetts, 7th Edition 2012
4. **L. A. Pipe**, Applied Mathematics for Engineers and Physicists, Dover Publication Inc., Mineola, New York 3rd Edition 2014.
5. **E. Kreyszig**, Advanced Engineering Mathematics, John Wiley & Sons. Hoboken, New Jersey (United States), 10th Edition, 2015.
6. **K. F. Riley, M.P. Hobson, and S. J. Bence,** Mathematical methods for Physicists and Engineers, S. CHAND (Cambridge University Press), New Delhi, 3rd edition, 2018.
7. **V. BALAKRISHNAN,** Mathematical Physics with Applications, Problems and Solutions, Ane Books, New Delhi, 1st Edition, 2018

Classical Mechanics

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Classical Mechanics</td><td colspan="2">L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
I
(1^{st} Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td colspan="2">3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td colspan="2">Internals</td><td>30 Marks</td><td colspan="3">Examination Duration:3 hours</td></tr>
<tr><td colspan="2">End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: B.Sc.</td></tr>
<tr><td>Course Description</td><td colspan="8">This course aims at providing knowledge of Classical Mechanics to the students so that they are able to understand the Lagrangian & Hamiltonian mechanics of systems of particles interacting with various forces and also their applications in various branches of Physics.</td></tr>
<tr><td>Course Objectives</td><td colspan="8">• To understand the fundamentals of classical mechanics
• To get familiar with various classical mechanical problems related to Lagrangian & Hamiltonian formulations
• To aware the students about applications of classical mechanics in various science branches</td></tr>
</table>

Course Outcomes	After completion of this course, students would be able to: • Understand the mechanics of system of particles, D'Alembert's principle, Lagrangian mechanics, & Euler's equation of motion. • Learn about Hamiltonian formulation, Hamilton's Equations of Motion and Principle of least action. • Learn Canonical Transformations & Hamilton-Jacobi theory. • Learn about Rigid body dynamics including problems. • Understand the two body central force problem and its related aspects.

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Lagrangian Formulation and Hamilton's Principles:** Mechanics of one and many particle systems, Virtual work, Constraints of motion, generalized coordinates, D'Alembert's Principle and Euler-Lagrange Equations of motion, velocity dependent potentials, dissipation function, simple applications of Lagrangian formulation. Calculus of Variations, Hamilton's Principle, Derivation of Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, Symmetry Properties of space and time, Conservation theorems	15
2	**Hamilton's Equations of Motion and Small Oscillations:** Generalized momentum, Legendre transformation and the Hamilton's Equations of Motion, simple applications of Hamiltonian formulation, cyclic coordinates, Routh's procedure, Hamiltonian Formulation of Relativistic Mechanics, Derivation of Hamilton's canonical equation from Hamilton's variational principle. The principle of least action. Stable and unstable equilibria; Theory of small oscillations in Lagrangian formulation, normal coordinates and its applications, Free vibrations of linear triatomic oscillator.	15

3	**Canonical Transformation and Hamilton-Jacobi Theory:** Canonical transformation and its examples, integral invariant of Poincare, Lagrange's and Poisson brackets as canonical invariants, equation of motion in Poisson bracket formulation, Angular momentum, Infinitesimal contact transformation and generators of symmetry, Liouville's theorem. Hamilton-Jacobi equation for Principal and characteristic function, Harmonic Oscillator Problem, Action angle variable: adiabatic invariance of action variable.	15
4	**Two-body Central Force problem and Rigid Body Motion:** Two body central force problem: Reduction to equivalent one body problem, equation of motion and first integrals, Equivalent 1D problem, classification of orbits, Differential equation for the orbit, Kepler's problem, Scattering cross section, Rutherford's Formula. Orthogonal transformation, Euler equations, Eulerian angles ad Euler's Theorem, Infinitesimal rotation, Rate of change of a vector, Coriolis force, Angular Momentum and Kinetic energy of a rigid body, moment of Inertia, Eigenvalues of the inertia tensor.	15

TEXT BOOKS

1. **A. Sommerfeld,** Mechanics, Academic Press, United States, 1st Edition, 1952.
2. **I. Percival and D. Richards**, Introduction to Dynamics, Cambridge University Press, 1st Edition1982.
3. **Ronald L. Greene,** Classical Mechanics with Maple, Springer, Germany, 2nd Edition, 2000.
4. **Herbert Goldstein, Charles Poole, John Safko,** Classical Mechanics, Pearson Education,UK, 3rd Edition, 2011.
5. **L.D. Landau and E.M. Lifshitz,** Mechanics, Butterworth-Heinemann, UK, 2nd Edition, 2012.
6. **N.C. Rana and P.S. Joag,** Classical Mechanics, Tata McGraw Hill, New Delhi, 1st Edition, 2015.

QUANTUM MECHANICS - I

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Quantum Mechanics – I</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester: I</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs: M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks : 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: Graduation Level Quantum Mechanics</td></tr>
<tr><td>Course Description</td><td colspan="7">This course is designed for fundamental knowledge of quantum mechanics, which has comprehensive and rich applicability in condensed matter physics, atomic and molecular physics, nuclear physics, space science, and chemistry.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To understand the fundamentals of quantum mechanics
• To make familiar with various quantum mechanical problems related to vector space, eigenvalue, Schrödinger equation, free particle, harmonic oscillator, potential barrier and well, angular momenta etc.
• To aware the students about applications of quantum mechanics in various science branches</td></tr>
</table>

<table>
<tr><td>Course Outcomes</td><td colspan="2">After competition of this course, students will be able
To explain the theories and phenomena of vector space, operators, Dirac’s notations, matrices, and commutators which are very helpful in solving the various quantum mechanics problems
To understand the uncertainty relation between two arbitrary operators
To distinguish the actual meaning of time independent and time dependent Schrodinger’s equations
To illustrate Ehrenfest theorem, Poisson Brackets, wave packets and wave functions position and momentum space
To analyze the energy eigenvalues and wave functions of harmonic oscillator, infinite and finite square wells, free particle, and hydrogen atom
To determine the transmission and reflection coefficients of potential barrier and potential step, and delta function well
To recognize the importance of angular momentum and its applications in quantum mechanics
To explain the physics behind the addition of angular momenta</td></tr>
<tr><td colspan="3">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td>Content of Each Unit</td><td>Hours of Each Unit</td></tr>
<tr><td>1</td><td>Mathematical Tools of Quantum Mechanics:

Vector Spaces, Linear Independence, Bases, Dimensionality, Linear Transformations, Similarity Transformations, Eigen Values and Eigen Vectors, Inner Product, Orthogonality and Completeness, Hilbert Space, Hermitian and Unitary Operators, Orthonormality, Completeness and Closure, Dirac’s Bra and Ket Notation, Matrix Representation and Change of Basis, Operators and Observables, Commutation Relations, Uncertainty principle for two arbitrary Operators.</td><td>15</td></tr>
</table>

2	**Quantum Dynamics:** Time Evolution Operator, Stationary States, Schrodinger Equation, The Schrodinger versus the Heisenberg Picture, The Infinite Square Well and the Simple Harmonic Oscillator: Energy Eigenvalues and Energy Eigenstates, Connecting Quantum to Classical Mechanics: The Ehrenfest Theorem; Poisson Brackets and Commutators, Wave Packets, Wave Functions in Position and Momentum Space.	15
3	**Quantum Mechanics in One and Three Dimensions:** Properties of One Dimensional Motion: Bound States and Scattering States, The Free Particle, The Potential Step, The Potential Barrier and Well, The Finite Square Well, The Delta- Function Well, Three Dimension Problems: Hydrogen Atom.	15
4	**Angular Momenta and Approximate Analysis:** Orbital angular momentum, General Formalism of Angular Momentum, Eigenfunctions and Eigenvalues of Orbital Angular Momentum, Addition of Angular Momenta, Spin Angular Momentum: Stern-Gerlach Experiment; Pauli Matrices and Spinors, Clebsch-Gordan Coefficients.	15

TEXT BOOKS

1. **L. D. Landau and E.M. Lifshitz**, Quantum Mechanics, Butterworth Heinemann, The Netherlands, 3rd Edition, 1981.
2. **P. A. M. Dirac**, The Principles of Quantum Mechanics, Oxford University Press, UK, 4th Edition, 1988.
3. **R. Shankar**, Principles of Quantum Mechanics, Springer, Germany, 2nd Edition, 1994.
4. **N. Zettili**, Quantum Mechanics: Concepts and Applications, Wiley, USA, 2nd Edition, 2009.
5. **J. J. Sakurai**, Modern Quantum Mechanics, Pearson, India, 2nd Edition, 2013.
6. **L. I. Schiff**, Quantum Mechanics, McGraw Hill Education, USA, 4th Edition, 2017.
7. **D. J. Griffiths**, Introduction to Quantum Mechanics, Cambridge University Press, UK, 3rd Edition, 2018.
8. **C. Cohen-Tannoudji, B. Diu, and F. Laloe**, Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, Wiley, USA, 2nd Edition, 2019.

Semiconductor Devices

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Semiconductor Devices</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
I
(1^{st} Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours:
60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: None</td></tr>
<tr><td>Course Description</td><td colspan="7">The objective of the course on Semiconductor Devices is to introduce semiconductor physics, physical principle of devices and their basic applications.</td></tr>
<tr><td>Course Objective</td><td colspan="7">• An understanding of basic semiconductor device physics
• An understanding of the application of Field-Effect Transistors.
• An understanding of the application of Bipolar Junction Transistors.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course, student would be able:
• To understand the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.
• To understand how to find the Fermi energy level and carrier density in n- type and p-type semiconductors.
• To understand basic properties of PN junctions and Metal-Semiconductor junction.
• To understand the working, design and applications of various semiconducting devices like rectifiers, clippers, LED, Solar cells.
• To understand the working, design, and applications of BJTs and FETs.
• To understand the working, design and applications of Operational Amplifier</td></tr>
</table>

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Semiconductors:** Energy Band and Charge Carriers: Energy bands in semiconductors, Types of semiconductors: Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration in equilibrium, Temperature dependence of carrier concentration, Compensation and charge neutrality. Conductivity and mobility: Effect of temperature, Doping and high electric field, Hall Effect.	**15**
2	**Junctions:** p-n junction and contact potential, Fermi levels, Space charge, Reverse and Forward bias, Zener and Avalanche breakdown. Capacitance of p-n junction, Diode Applications: Load-Line Analysis, Series Diode Configurations, Parallel and Series-Parallel Configurations (AND/OR Gates), Half-Wave Rectification, Full-Wave Rectification, Clippers, Clampers. Network with a DC and AC Source, LED, Solar cell and photodetectors, Metal-Semiconductor contact: Rectifying contact and Ohmic contact.	**15**
3	**Bipolar Junction Transistors (BJT):** Fundamentals of BJT, BJT Operation: Common-Base Configuration, Common-Emitter Configuration, Common-Collector Configuration, Limits of Operation, Minority carrier distribution, BJT DC Biasing: Operating Point, Fixed-Bias Configuration, Emitter-Bias Configuration, Voltage-Divider Bias Configuration, Collector Feedback Configuration, Emitter-Follower Configuration, **Field Effect Transistors:** JEFT: Construction and Characteristics of JFETS, Transfer Characteristics, MOSFET: Depletion-Type MOSFET, Enhancement-Type MOSFET, Transfer Characteristics.	**15**
4	**Operational Amplifiers:** Differential amplifier (DA)- Basic circuit of differential amplifier Operation of differential amplifier: Common-mode rejection ratio	

	(CMRR), DC analysis of differential, Applications of OP-amp: Inverting amplifier-Input and impedance of inverting amplifier, Noninverting amplifier-Voltage follower, Effect of negative feedback on OP-amp in feedback circuits, Summing amplifiers-Applications of summing amp, OP-amp as integrators and differentiators.	

TEXT BOOKS

1. **J.J. Cathey**, Schaum's Outline of Electronic Devices and Circuits, McGraw Hill, New York, 2nd Edition 2002.
2. **B. Streetman and S. Banerjee**, Solid State Electronics, Prentice Hall India, New Delhi, 6th Edition, 2006.
3. **Millman and Halkias**, Integrated Electronics, McGraw Hill, New York, 2nd Edition 2009.
4. **A.P. Malvino**, Electronic Principles, McGraw, New Delhi, New York 7th, Edition, 2009.
5. **J.H. Moore, C.C. Davis and M.A. Coplan**, Building Scientific Apparatus, Addison Wesley, United States, 4th Edition 2009.
6. **R.L. Boylestad and L. Nashelsky**, Electronics Devices and Circuit Theory, Prentice Hall of India, New Delhi, 11th Edition, 2013.
7. **P. Horowitz and W. Hill**, The Art of Electronics, Cambridge University Press, 3rd Edition, 2015.

LABORATORY I

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Laboratory I</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
I (1st Year)</td><td>Contact Hours per Week: 12</td></tr>
<tr><td>0</td><td>0</td><td>12</td><td>6</td><td>Total Hours:
180</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: None</td></tr>
<tr><td>Course Description</td><td colspan="7">The objective of the lab 1 is to train students to perform various experiments associated with Electronics, Quantum physics, Waves mechanics and Spectroscopy. Students assigned the general laboratory work will perform at least ten (10) experiments of the above mentioned list of Physics experiments and further 8 experiments from the C programming section.. Experiments of equal standard may be added. Workshop soldering and designing of experiments should be included</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To give hands on experience to students for generating magnetic field and measurement of various parameters.
To teach how temperature controlled oven works
To take measurements of current and voltage using various equipment</td></tr>
</table>

Course Outcomes	After competition of this course, the students will be able to • learn various Physics aspects by performing the experiments related to electronic devices, atomic and molecular physics, light wave, sound waves etc. • Learn Error analysis • Use excel for plotting graphs • do C programming

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	1. Hall Effect 2. Four Probe Method to find band gap of semiconductor 3. Electron Spin Resonance 4. Frank-Hertz experiment 5. PN Junction characteristics 6. Solar cell characteristics 7. Velocity of ultrasonic wave in liquids 8. Characteristics of MOSFET 9. Diode as voltage regulator 10. Ionization potential of mercury 11. Planck's constant using LED 12. Law of Malus 13. Zener diode characteristics	150
2	Introduction to C Programming: 1. Write a Program to calculate and display the volume of a CUBE having its height, width and depth. 2. Write a C program to perform addition, subtraction, division and multiplication of two numbers 3. Write a program to input two numbers and display the maximum number. 4. Write a program to find the largest and smallest among three entered numbers and also display whether the identified largest/smallest number is even or odd. 5. Write a program to find the roots of quadratic equation. 6. Write a program to check whether the entered year is leap year or not (a year is leap if it is divisible by 4 and divisible by 100 or 400.)	30

	7. Write a program to find the factorial of a number. 8. Write a program to check number is Armstrong or not. 9. Write a program to find GCD (greatest common divisor or HCF) and LCM (least common multiple) of two numbers Write a program to generate Fibonacci series.	

TEXT BOOKS

1. Worsnop and Flint, Experimental Physics, Little hampton Book Services Ltd, United Kingdom, 9th Edition, 1951.
2. C. Melissinos, J. Napolitano, Experiments in Modern Physics, Academic Press, Cambridge, Massachusetts, 2nd Edition, 2003.
3. Lab manuals, prepared by faculty of the Department of Physics, 2018.

Modern Optics

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Modern Optics</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
I
(1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks : 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: B.Sc. with Physics</td></tr>
<tr><td>Course Description</td><td colspan="7">The course has focus on the Geometrical and wave optics, thin films, Holography, optical fiber, liquid crystals, LED and Photonic band gap crystals.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To understand the fundamentals of optics.
• To impart knowledge about different physical phenomena.
• To update the students with the latest technologies.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After completion of this course, students would be able to:
• Understand the various physical phenomena & their real life applications.
• Learn about the wave optics and holography.
• Get knowledge about the basics of Lasers.
• Learn about the fiber optics & LED.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="5">Content of Each Unit</td><td colspan="2">Hours of Each Unit</td></tr>
</table>

1	**An overview of Geometrical and Wave Optics:** Laws of Reflection, Refraction, Total Internal Reflection; Ideas of Interference, Diffraction, Polarization, Dispersion.	15
2	**Fresnel Relations:** Conductors, Thin Films: Reflection Model, Matrix Formalism, Coating Design, Fourier Optics: Wave Propagation, Fraunhofer Diffraction, Fresnel Diffraction, Spatial Filtering, Holography and Holograms.	15
3	**Coherence, Interference and Visibility, Laser Physics:** Overview, Gain Saturation, Light-Atom Interactions, Optical Gain and Pumping Schemes, Output Characteristics, Light Shifts and Optical Forces, Atom-Photon interactions.	15
4	**Fiber Optics:** Mode Analysis, Single mode and multimode optical fiber, Loss and Dispersion, Photonics Band-gap Crystals, Liquid crystals, Introduction of LED.	15

TEXT BOOKS

1. 1. **A. E. Siegman,** Lasers, University Science Book, USA,Revised Edition, 1986.
2. **G. R. Fowles,** Introduction to Modern Optics, Dover Publication, USA, 2nd Edition, 1989.
3. **J. T. Verdeyen,** Laser Electronics, Prentice-Hall, India,New Delhi, 3rd Edition, 1995.
4. **E. Hecht,** Optics, Addison Wesley, USA, 4th Edition, 2001.
5. **Pedrotti,**Introduction to Optics, Pearson UK, 3rd Edition, 2006.
6. **B. E. A. Saleh and M. C. Teich,** Fundamentals of Photonics, Wiley,United States, 2nd Edition, 2012.
7. **A. Ghatak,** Optics, Tata McGraw-Hill, New Delhi, 6th Edition, 2017.

RENEWABLE ENERGY RESOURCES

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the Subject:
Renewable Energy Resources</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester :
I (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation (Total Marks):
100</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Pre-requisite of course:
10+2 with Non-Medical</td></tr>
<tr><td>Course Description</td><td colspan="7">To introduce the pattern of fuel consumption, energy demand, various renewable sources of energy and modern applications.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• The course treats the basics of various renewable energy resources and energy generation using different methods; it is suitable for students from interdisciplinary background.</td></tr>
<tr><td>Course Outcome</td><td colspan="7">On completion of this course, student will learn:
• The Course will create awareness among students about Non-Conventional sources of energy technologies and provide adequate inputs on a variety of issues.
• The Course will be introducing the students to all the aspects of PV technology. This will enable them to understand the requirements for PV materials and PV systems for different applications.
• It creates awareness among students about wind and geothermal energy technologies and provide adequate inputs on a variety of issues.
• To teach fundamentals of hydrogen energy as energy systems, production processes, storage, utilization, and safety that is necessary for taking some important elective subjects.
• It increases the potential for job opportunities in automotive industries and hydrogen production & its infrastructure development related sectors as about 40% energy is being consumed by automotive sectors.
• To give an idea about different biomass and nuclear as energy source and their processing and utilization for recovery of energy and other valuable products. A comprehensive knowledge of how wastes are utilized for recovery of value</td></tr>
</table>

	would be immensely useful for the students from all Fields.	
COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1.	**Energy Scenario and Solar Energy:** Global and Indian Energy Scenario and Energy Policy, Commercial and Noncommercial Forms of Energy, Fossil Fuels, Renewable Sources, Impact of Energy Systems on Environment, Need for use of New and Renewable Energy Sources, Solar Thermal and Solar Photovoltaic Energy.	15
2.	**Wind and Geothermal Energy:** Wind Energy Basics- Global circulation, Forces influencing Wind - Pressure gradient force and Coriolis force, Local and Regional Wind systems, Geothermal Tidal and Wave Energy, Geothermal regions, geothermal sources, Geothermal energy conversion technologies.	15
3.	**Hydrogen Energy and Fuel cells:** Hydrogen Energy-production and storage, Production Processes: Thermo chemical Water Splitting, Gasification, Pyrolysis methods. Electrochemical, Electrolysis, Photo electro chemical. General storage methods, compressed storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage. Fuel cells- Thermodynamics and performance of Fuel Cells, Its working, construction, classifications and applications.	15
4.	**Biomass and Nuclear Energy:** Biomass Energy and application, Techniques for biomass assessment, Thermochemical conversion of biomass, Mini/micro hydro power: classification of hydropower schemes, Nuclear Energy: Fission, Fusion, Different type of nuclear reactors, Nuclear waste disposal and environment measures.	15

TEXT BOOKS

1. Solar Energy: S. P. Sukhatme, (Tata McGraw Hill).
2. Garg .H.P,Prakash .J, “Solar energy fundamentals and applications”, Tata McGraw Hill publishing Co. Ltd, 2006.
3. Xianguo Li, Principles of Fuel Cells, Taylor and Francis, 2005.
4. Fundamentals of Renewable Energy Processes, Aldo Vieira da Rosa, Elsevier Academic Press.
5. J Twidell and T Weir, Renewable Energy Resources, Taylor and Francis (Ed), New York, USA, 2006.
6. KC Khandelwal, SS Mahdi, Biogas Technology - A Practical Handbook, Tata McGraw Hill, 1986.
7. EH Lysen, Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983.

STATISTICAL MECHANICS

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Statistical Mechanics</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course:
Graduation Level Quantum Mechanics and Mathematical Physics</td></tr>
<tr><td>Course Description</td><td colspan="7">This course is developed for understanding of thermodynamics and statistical mechanics, which have broad and rich applicability in quantum mechanics, condensed matter physics, classical mechanics and electrodynamics.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To understand the fundamentals of thermodynamics and statistical mechanics
• To make familiar with various thermodynamical and statistical mechanics terms such as entropy, free energy, phase space, statistical ensembles, Bose-Einsteinstatistics, Fermi-Dirac statistics etc.
• To able the students for solve the problems related to thermodynamics and statistical physics</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of this course, the students will be able to
• explain the various thermodynamical quantities and Maxwell’s relations
• apply the thermodynamics in ideal gas, magnetic and dielectric materials
• describe various statistical approaches which describe systems of particles</td></tr>
</table>

	• evaluate the formulae of random walk and diffusion equation • compare microstates, macrostates, and statistical ensembles • understand the theories and mathematical approaches of statistical ensembles, equipartition theorem and Maxwell-Boltzmann statistics • illustatre the fundamental concepts of Bose-Einstein and Fermi-Dirac Statistics • calculate the problems related to Bosons and Fermions

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Review of Thermodynamics:** Extensive and intensive variables, laws of thermodynamics, Entropy for Different Systems, Gibbs Paradox, Boltzmann Relation for Entropy, Legendre Transformations and Thermodynamic Potentials, Chemical Potential, Free Energy and Its Connection with Thermodynamic Quantities, Maxwell Relations, Applications of Thermodynamics to (a) Ideal Gas, (b) Magnetic Material, and (c) Dielectric Material.	15
2	**Statistical Methods and Description of Systems of Particles :** Binomial distribution, Poisson distribution, Gaussian distributions, Central Limit Theorem, Random Walk and Brownian Motion, Diffusion Equation, Phase Space, Liouville's Theorem, Phase Equilibrium, Microstates and Macrostates, Statistical Ensembles, Irreversibility and the Attainment of Equilibrium	15
3	**Classical Statistical Mechanics:** Micro-Canonical Ensemble, Canonical Ensemble: Derivation of Partition Function and Thermodynamic Quantities; Mean Values and Fluctuations, Grand Canonical Ensemble: Gibbs Factor; Gibbs Distribution; Derivation of Partition Function and Thermodynamic Quantities; Fluctuations in the Number of Particles, Applications of Canonical and Grand Canonical Ensembles, Equipartition Theorem and It's Applications, Maxwell-Boltzmann Statistics.	15

4	**Quantum Statistical Mechanics:** Bosons: Occupation Number; Bose-Einstein Statistics; Debye Theory of Specific Heat; Grand partition function For Ideal Bose Gas; Black-Body Radiation; Bose-Einstein Condensation, Fermions: Occupation Number; Fermi-Dirac Statistics; IdealFermi gas, Pauli Paramagnetism, First and Second Order Phase Transitions, Ising Model, Phase Equilibria: Equilibrium Conditions; Simple Phase Diagrams; Clausius-Clapeyron Equation.	15

TEXT BOOKS

1. **F. Reif**, Fundamental of Statistical and Thermal Physics, McGraw-Hill, USA, 1965.
2. **L. D. Landau and E. M. Lifshitz**, Statistical Physics, UK, 3rd Edition, 1980.
3. **D. V. Schroeder**, An Introduction to Thermal Physics, Addison Wesley Longman, UK, 2000.
4. **J. P. Sethna**, Statistical Mechanics: Entropy, Order Parameters and Complexity, Oxford University Press, UK, 2006.
5. **M. Kardar**, Statistical Physics of Particles, Cambridge University Press, UK, 2007.
6. **H. Gould and J. Tobochnik**, Statistical and Thermal Physics: With Computer Applications, Princeton University Press, USA, 2010.
7. **K. Huang**, Statistical Mechanics, Wiley, India, 2nd Edition, 2011.
8. **R. K. Pathria and P. D. Beale**, Statistical Mechanics, Academic Press, USA, 2011.

Classical Electrodynamics

<table>
<tr><td rowspan="2">Scheme Version :
2024-25</td><td rowspan="2">Name of the subject:
Classical Electrodynami c s</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II
(1st Year)</td><td>Contact Hours per Week: 4</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc.Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: None</td></tr>
<tr><td>Course Description</td><td colspan="7">This course is designed for fundamental knowledge of basic electrodynamics and it’s applications to various phenomena.</td></tr>
<tr><td>Course Objective</td><td colspan="7">• To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method.
• To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course, student would be able:
• To understand the basics of electrostatics
• To use of Maxwell equations in analyzing the electromagnetic field due to time varying charge and current distribution.
• To describe the nature of electromagnetic wave and its propagation through different media and interfaces.</td></tr>
</table>

	• The students will be able to analyze s radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate. • The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration. • To explain charged particle dynamics and radiation from localized time varying electromagnetic sources.

COURSE SYLLABUS

Unit No.	Content of Each Unit	Hours of Each Unit
1	**Electrostatics :** Coulomb's law, Guass's law, Poisson's equation, Laplace equation, Green's theorem, , Dirichlet and Neumann boundary conditions, Simple boundary value problems illustrating various techniques such as method of images, separation of variables, Green's functions, Multipole expansion. Electrostatics of dielectric media, multipole expansion of energy of a charge distribution in an external field, Boundary value problems with dielectrics; molecular polarisability, Clausius Mossotti Relation, electrostatic energy in dielectric media.	**15**
2	**Magnetostatics & Maxwell's Equations:** Biot-Savart law, Ampere's Law, Vector potential, Magnetic Fields of a Localized Current Distribution, Magnetic Moment , Force and Torque on and Energy of a Localized Current Distribution in an External Magnetic Induction, Singularity in dipole field, Fermi-contact term, Macroscopic Equations, Boundary Conditions on B and H, Methods of Solving Boundary-Value Problems in Magnetostatics, Uniformly Magnetized Sphere, Magnetized Sphere in an External Field; Permanent Magnets, Magnetic Shielding, Maxwell's Displacement Current; Maxwell Equations, Vector and Scalar Potentials, Gauge transformations, Lorentz and Coulomb gauges, Hertz Potential, Time varying fields, Maxwell's equations in free space and linear isotropic media (non conducting) boundary conditions on the fields at interfaces. Poynting theorem, conservation laws for a system of charged particles and electromagnetic field,	**15**
3	**Electromagnetic Waves:** Electromagnetic waves in free space, dielectrics and conductors, skin depth, Plane waves in a non conducting media, Reflection and refraction, polarization, Fresnel's law, Total internal Reflection: Stoke's parameter, Waves in rarefied plasma (ionosphere) and cold magneto-plasma,	**15**

	frequency dispersion in Dielectrics, Metals and Plasmas, dielectric constant and anomalous dispersion, wave propagation in Ionosphere and Magnetosphere, group velocity, metallic wave guides, Energy Flow and Attenuation in Waveguides, Coaxial cable, Resonant Cavities, Power Losses in a Cavity; Q of a Cavity, M, propagation modes in waveguides.	
4	**Radiation and Relativistic Electrodynamics:** Field of a localized oscillating source, fields and radiation in dipole and quadrupole Fields, Centre-fed Linear Antenna, Non-relativistic motion in uniform constant fields, Slowly varying magnetic field : Time varying magnetic field, space varying magnetisc field, Adiabatic invariance of flux through an orbit, magnetic mirroring. Lorentz Transformation, Lorentz invariance of Maxwell's equation. Dynamics of charged particles in static and uniform electromagnetic fields. Radiation- from moving charges and dipoles and retarded potentials, Lienard-Wiechert potentials, Total power radiated by an accelerated charge, Lorentz formula. Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.	**15**

TEXT BOOKS

1. **L.D. Landau** and E.M. Lifshitz, Classical Theory of Electrodynamics, Butterworth-Heinemann. Germany, 4thEdition, 1987.
2. **S.P. Puri** , Classical Electrodynamics, Narosa Publishing House, 2011.
3. **Melvin Schwartz**, Principles of Electrodynamics, Dover Publications, UK, 1st Edition, 1987.
4. **Walter Greiner**, Classical Electrodynamics, Springer, Germany, 1st Edition, 1998.
5. **J. Schwinger**, L.L. Deraad Jr, K.A. Milton, W-Y. Tsai and J. Norton, Classical Electrodynamics, WestviewPress, UK, 1998.
6. **David J. Griffiths**, Introduction to Electrodynamics, Benjamin Cummings, USA, 3rd Edition, 1999.
7. **J.D. Jackson**, Classical Electrodynamics, John Wiley & Sons, United States, 2nd Edition, 2003.
8. **Charles A. Brau**, Modern Problems in Classical Electrodynamics, Oxford University Press, 1st Edition, 2003.
9. **L. D. Landau** and E. M. Lifshitz & L. P. Pitaevskii, Electrodynamics of Continuous Media Oxford, 1st Edition,2005.
10. **Wolfgang K. H. Panofsky** and Melba Phillips, Classical Electricity and Magnetism, Dover Publications, UK,2nd Edition, 2012.
11. **Joseph Edminister**, Schaum's outline of electromagnetics, New Delhi, 2nd Edition, 2017.

Mathematical Methods in Physics-II

Scheme Version: 2024-26	Name of the subject: Mathematical Methods in Physics-II	L	T	P	C	Semester:	Contact Hours per Week: 4
		3	1	0	4	II (1^{st} Year)	Total Hours: 60=45+15
Subject Code:	Applicable to Programs: M.Sc. Physics	Evaluation (Total Marks: 100)	Internals	30 Marks	Examination Duration: 3 hours		
			End Term	70 Marks	Prerequisite of Course: Mathematical Methods in Physics I		
Course Description	This course has been developed to introduce students to some topics of mathematical Physics which are directly relevant in different subjects of M.Sc. Physics. It includes Ordinary differential equation, special functions and different transformation methods to solve differential equation.						
Course Objectives	**To Make the students familiar with** • Partial and Ordinary differential equations in Physics. • Power series method of their solution and different polynomials • Fourier Transform and Laplace Transform as a tool to solve differential equation.						
Course Outcomes	**On completion of the course, student would be able to:** • to solve second order differential equation. • to use the special function in Quantum mechanics and electrodynamics • to perform Fourier transform on a given data set. • to perform Laplace transform on a given data set.						

COURSE SYLLABUS

Unit No.	Content of Each Unit	Hours of Each Unit
1	**Second Order Differential Equations :** Separation of variables-ordinary differential equations, singular points, series solutions leading to Legendre, Bessel, Hermite, Laguerre functions as solutions. Orthogonal properties and recurrence relations of these functions.	15
2	**Special functions :** Spherical harmonics and associated Legendre polynomials. Sturm -Liouville systems and orthogonal polynomials. Wronskian linear independence and/ linear dependence.	15

3	**Fourier Transforms:** Fourier Transforms: Development of the Fourier integral from the Fourier Series, Fourier and inverse Fourier transform, Convolution theorem. Simple Applications: FTIR, Telecommunication systems, Solution of partial differential equation wave equation	15
4	**Laplace Transforms:** Laplace transforms and their properties, Convolution theorem, Application of Laplace transform in solving linear, differential equations with constant coefficient, with variable coefficient and linear partial differential equation.	15

TEXT BOOKS

1. **Merle C. Potter and Jack Goldberg**, Mathematical Methods, S. CHAND (Prentice Hall of India), New Delhi, 2nd Edition, 1987.
2. **Fredrick W. Byron and Robert W. Fuller**, Mathematics of Classical and Quantum Physics, Dover Publications, UK, Vol 1 &2, 1970.
3. **George Arfken and Hans J Weber**, Mathematical Methods for Physicists, Elsevier Academic Press, Cambridge, 7th Edition, 2012.
4. **L. A. Pipe**, Applied Mathematics for Engineers and Physicists, Dover Publication Inc. 2014.
5. **E. Kreyszig**, Advanced Engineering Mathematics, John Wiley & Sons, United States, 10th Edition, 2015,
6. **K.F.Riley, M.P. Hobson, and S.J.Bence,** Mathematical methods for Physicists and Engineers, S. CHAND (Cambridge University Press), New Delhi, 3rd Edition, 2018.
7. **V Balakrishnan:** Mathematical Physics with Applications, Problems and Solutions; Ane Books, 1st Edition, 2018.

LABORATORY-II

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Laboratory-II</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact Hours per Week: 12</td></tr>
<tr><td>0</td><td>0</td><td>12</td><td>6</td><td>Total Hours: 180</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: None</td></tr>
<tr><td>Course Description</td><td colspan="7">The aim & objective of the course is to impart the practical training on various electronics devices such as; Op-Amp, Vibrators, Amplifiers, Michelson interferometer etc. Students assigned the general laboratory work will perform at least twelve (12) experiments from the above mentioned. More experiments of similar nature may be added.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">To train students for various electronics experiments and take measurements
To train students on various optical instruments like Spectrometer, Michelson Interferometer
To have hand on experiment for measurement of magnetoresistance and dielectric constant.</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After completion of this course, the students will be able to
Understand spectral lines, grating spectra, and interference fringes
Learn the characteristics of Op-Amp, vibrators, clipper, clampers, and DA/ AD
Use excel for plotting graphs
Understand motion of temperature and magnetic field dependence of Hall coefficient.</td></tr>
</table>

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	1. Study of Balmer series and Rydberg constant 2. Op-Amp as inverting and non-inverting amplifier 3. Op-Amp as differentiator, Integrator and Adder 4. e/m by Thomson method 5. Single stage RC coupled amplifier 6. Frequency response of common emitter amplifier 7. Bistable/Monostable/Astable vibrators 8. Grating spectra 9. Refractive index of water and oil using prism 10. Magneto resistance 11. Temperature dependence of Hall coefficient 12. Digital to Analog converter, Analog to Digital converter 13. Michelson Interferometer 14. Faraday Effect 15. Clipper and clampers	150
2	1. Root finding of a polynomial equation using numerical methods 2. Solving first and second order differential equation numerical methods 3. Numerical integration 4. Generating finite and infinite series	30

TEXT BOOKS

1. **Worsnop and Flint,** Experimental Physics, Little hampton Book Services Ltd, United Kingdom, 9th Edition, 1951.
2. **A. C. Melissinos, J. Napolitano,** Experiments in Modern Physics, Academic Press, Cambridge, Massachusetts, 2nd Edition, 2003.
3. 3. Lab manuals, prepared by faculty of the Department of Physics, 2018.

QUANTUM MECHANICS - II

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject: Quantum Mechanics – II</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs: M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: Quantum Mechanics-I</td></tr>
<tr><td>Course Description</td><td colspan="7">This course is designed to understand some advanced topics such as symmetries, identical particles, approximation methods and relativity in quantum mechanics, which has broad and rich applicability in condensed matter physics, atomic andmolecular physics, nuclear physics, space science, and chemistry.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To make familiar with various advanced topics of quantum mechanics such as symmetries and conservation laws, fermions and bosons, time independent and time dependent perturbation theories, variational and WKB methods, scattering theory, delta function and relativistic theory
• To aware the students about applications of advanced phenomena of quantum mechanics in physical, mathematical and chemical sciences</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After completion of this course, students will be able to
• understand the concepts of symmetries, conservation laws, bosons and fermions in
• quantum mechanics
• apply symmetries and conservation laws in various quantum mechanical problems
• illustatre the time independent and time dependent perturbation theories, the variational and WKB methods
• describe the fine structure and Zeeman effect phenomena</td></tr>
</table>

	• explain the basics of scattering theory • apply the delta function's properties in various quantum mechanical problems • understand the basics of relativistic quantum mechanics • recognize the importance and applications of relativistic quantum mechanics

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Symmetries, Conservation Laws & Identical Particles** Transformation in space, The Translation Operator, Translation Symmetry, Conservation Laws, Parity: Parity in One & Three Dimensions; Parity Selection Rules, Rotational Symmetry, Degeneracy, Rotational Selection Rules, Many Particle Systems, Systems of Identical Particles, The Helium Atom, The Pauli Exclusion Principle.	15
2	**Approximation Methods** Time Independent Perturbation Theory: Nondegenerate Perturbation Theory; Degenerate Perturbation Theory; Fine Structure; The Zeeman Effect, The Variational Method, The WKB method, Time Dependent Perturbation Theory, Adiabatic & Sudden Approximations.	15
3	**Scattering Theory & The Delta Function** Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering, The Delta Function: One Dimensional Delta Function and Three Dimensional Delta Function.	15
4	**Relativistic Quantum Mechanics** Klein-Gordon equation, Dirac equation, Probability and Current	15

	Density, Plane Wave Solutions, Symmetries of the Dirac equation, Dirac's Equation for a Central Potential, Covariance of Dirac's Equation, Relativistic Hydrogen Atom Problem, The Hole Theory and Positrons.	

TEXT BOOKS

1. **L. D. Landau and E.M. Lifshitz**, Quantum Mechanics, Butterworth Heinemann, The Netherlands, 3rd Edition, 1981.
2. **P. A. M. Dirac**, The Principles of Quantum Mechanics, Oxford University Press, UK, 4th Edition, 1988.
3. **R. Shankar**, Principles of Quantum Mechanics, Springer, Germany, 2nd Edition, 1994.
4. **N. Zettili**, Quantum Mechanics: Concepts and Applications, Wiley, USA, 2nd Edition, 2009.
5. **J. J. Sakurai**, Modern Quantum Mechanics, Pearson, India, 2nd Edition, 2013.
6. **L. I. Schiff**, Quantum Mechanics, McGraw Hill Education, USA, 4th Edition, 2017.
7. **D. J. Griffiths**, Introduction to Quantum Mechanics, Cambridge University Press, UK, 3rd Edition, 2018.
8. **C. Cohen-Tannoudji, B. Diu, and F. Laloe**, Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, Wiley, USA, 2nd Edition, 2019.

Introduction to Astronomy and Astrophysics

<table>
<tr><td rowspan="2">Scheme Version:</td><td rowspan="2">Name of the subject: Introduction to Astronomy and Astrophysics</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact Hours per Week: 4</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation (Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite: General Mathematics</td></tr>
<tr><td>Course Description</td><td colspan="7">To make the students aware about different theoretical and observational technique adopted in understanding astrophysics and astronomy</td></tr>
<tr><td>Course Objectives</td><td colspan="7">The objective of this course is to make the students
• Understand coordinate systems in Astronomy
• Understand the Sun
• Understand Binary stars.
• Understand stellar distances</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course, student would be able to :
• differentiate between various coordinate systems
• know about the characteristics of Sun
• Know about Binary stars and their motions
• Know about stellar distances and other properties</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
<tr><td>Unit No.</td><td colspan="6">Content of Each Unit</td><td>Hours of Each Unit</td></tr>
</table>

1	**Observational Data:** Astronomical Coordinates- Celestial Sphere, Horizon, Equatorial, Ecliptic and galactic system of coordinates, Conversion from one coordinate system to another. Aspects of sky from different places on the earth. Twilight, Seasons, Sidereal. Apparent and Mean solar time and their relations. Calendar. Julian date and heliocentric correction. Determination of Mass, luminosity, radius, temperature and distance of a star, H-R Diagram, Empirical mass-luminosity relation.	15

2	**Stellar Distances and Magnitudes :** Distances of stars from the trigonometric, secular and moving cluster parallaxes. Stellar motions. Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magnitudes and distance modulus. Colour index. Black-body approximation to the continuous radiation and temperatures of stars. Variable stars as distance indicators.	15
3	**Binaries and Variable Stars :** Visual, spectroscopic and eclipsing binaries. Importance of binary stars as source of basic astrophysical data. Classification and properties of various types of intrinsic and eruptive variable stars. Astrophysical importance of the study of variable stars. Novae and Supernovae.	15
4	**Sun** : Physical Characteristic of Sun – Basic data, solar rotation, solar magnetic fields, Photosphere- granulation, sun-spots, Babcock model of sunspot formation, solar atmosphere-chromospheres and corona, Solar activity – flares, prominences, Solar wind, activity cycle, Helioseismology	15

TEXT BOOKS

1. **W.M.Smart**: Text book of Spherical Astronomy, Cambridge University Press; 6th edition, 1977
2. **M. Zeilik,** Astronomy, The evolving Universe, Cambridge University Press , 1st Edition, 2002.
3. **P.V. Foukal,** Solar Astrophysics , Wiley-VCH, United States, 1st Edition, 2004.

4. **I. Morrison,** Introduction to Astronomy and Cosmology, Wiley, United States, 1st Edition, 2008

FUNDAMENTALS OF SOLAR ENERGY

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the Subject:
Fundamentals of Solar Energy</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation (Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Pre-requisite of course:There is no prerequisite orco-requisite for this course. But students are expected to know basic semiconductor physics.</td></tr>
<tr><td>Course Description</td><td colspan="7">The course is intended for students who have interest in alternate energy sources as a contributor to sustainability. It provides a comprehensive treatise on the science and technology of solar energy, its collection and the design principles that need to be understood for its effective use in a variety of installations and uses.</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• The Course will be introducing the students to all the aspects of PV technology.
• To develop basic understanding related to fabrication ad characterization of different types of solar cells.
• To know state of art in the field of solar cells materials and solar cells.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="7">On completion of this course, student will learn:
• The available solar energy and the current solar energy conversion and utilization processes, solar spectrum.
• The factors that influence the use of solar radiation as an energy source.
• The various active and passive technologies that are available for collecting solar energy; have the ability to apply design principles to selection of an appropriate solar energy installation to meet requirements.
• How solar cells convert light into electricity, how solar cells are manufactured, how solar cells are evaluated.
• What technologies are currently on the market, and how to evaluate the risk</td></tr>
</table>

	• and potential of existing and emerging solar cell technologies. • To examine the potential & drawbacks of currently manufactured technologies, as well as pre-commercial technologies. How to enhance solar cell performance and reduce cost, and the major hurdles-technological and economic, towards widespread adoption.	
COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1.	**Solar Radiation:** origin, solar constant, spectral distribution of solar radiation, absorption of solar radiation in the atmosphere, global and diffused radiation, seasonal and daily variation of solar radiation, measurement of solar radiation, sun tracking systems, photo thermal conversion, solar energy collectors, collector efficiency and its dependence on various parameters.	15
2.	**Solar energy:** storage of solar energy, solar pond, solar water heater, solar distillation, solar cooker, solar green houses, solar dryers, absorption air conditioning. solar fuels: electrolysis of water, photoelectrochemical splitting of water.	15
3.	**Fundamentals of solar cells:** Photo voltaic effect, semiconductor properties, energy levels, basic equations, p-n junction its characteristics, fabrication steps, thermal equilibrium condition, depletion capacitance, junction breakdown, heterojunction. Silicon based solar cells: single crystal, polycrystalline and amorphous silicon solar cells.	15
4.	**Device physics**: Solar cell device structures, construction, output power, efficiency, fill factor and optimization for maximum power, surface structures for maximum light absorption, current voltage characteristics in dark and light, operatingtemperature vs conversion efficiency, charge carrier generation, recombination and other losses. Cadmium telluride solar cells, copper indium gallium selenide solar	15

	cells, organic solar cells, perovskite solar cells, Advanced concepts in photovoltaic research.	

TEXT BOOKS
1. S P Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 1996. **2.** Solid State Electronic Devices, Ben. G. Streetman, S. K. Banerjee, PHI Leaning Pvt. Ltd, 2000. **3.** D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000. **4.** Jasprit Singh, Semiconductor Devices, Basic Principles, Wiley, 2001 **5.** Stephen J.Fonash, Solar Cell Device Physics, 2nd edition, Academic Press, 2003. **6.** H P Garg, J Prakash, Solar energy fundamentals and applications, Tata McGraw Hill publishing Co. Ltd, 2006.

Accelerator Physics

Scheme Version:	Name of the subject:	L	T	P	C	Semester:	Contact hours per week: 3+1
2024-26	Accelerator Physics	3	1	0	4	II (1st Year)	Total Hours: 60=45+15
Subject Code:	**Applicable to Programs:** M.Sc. Physics	**Evaluation (Total Marks: 100)**	**CIE**	30 Marks	**Examination Duration:** 3 hours		
			TEE	70 Marks	**Prerequisite of Course:** Nuclear Physics, Electrodynamics, Quantum mechanics		
Course Description	This course is intended to expose the students to theoretical design and usage of various particle accelerators.						
Course Objectives	• To understand the beam optics. • Get knowledge about different types of accelerators • To understand the main features of superconducting cyclotron, linear accelerators and high energy accelerators.						
Course Outcomes	After completion of this course, students would be able to: • Understand the beam optics & beam transport system. • About various theoretical techniques to accelerate particles and technical details of electrostatic accelerators. • Get knowledge about latest accelerator technology based on Rf cavities. • About Synchrotron Radiations & production of radioactive ion beams.						

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Charged Particle Dynamics:** Particle motion in electric and magnetic fields, Beam transport system, Beam pulsing and bunching techniques, microbeams, Particle and ion sources, secondary beams, Measurement of beam parameters.	15
2	**Electrostatic and Heavy Ion Accelerators:** Van de Graaff voltage generator, Cockcroft-Walton voltage generator, insulating column, voltage measurement, Acceleration of heavy ions, Tandem electrostatic accelerator, Production of heavy negative ions, Pelletron and Tandetron, Cluster beams.	15
3	**Radiofrequency Accelerators:** Linear accelerators - Resonance acceleration and phase stability, electron and proton Linacs, Superconducting Heavy Ion Linear Accelerators. Circular accelerators- Cyclotron, Frequency Modulated Synchrocyclotron, AVF Cyclotron, Alternating-gradient accelerators.	15
4	**Synchrotron Radiation Sources:** Electromagnetic radiation from relativistic electron beams, Electron synchrotron, Characteristics of synchrotron radiation. Production of Radioactive ion beams, Polarized beams, Proton synchrotron, Colliding accelerators.	15

TEXT BOOKS

1. **M.S. Livingston and J.P. Blewel**, Particle Accelerators, McGraw-Hill Book Press, 1962.

2. **Ed. J. Cerny**, Nuclear Spectroscopy and Reactions Part-A, Academic Press, 1974.

3. **H.J. Wiedman**, Particle Accelerator Physics, Vol I and II, Springer Verlag, 1998.

4. **S. Y. Lee**, Accelerator Physics, World Scientific, Singapore, 2004

Radiation Physics

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Radiation Physics</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1^{st} Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration:3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: Nuclear Physics, Electrodynamics, Quantum mechanics</td></tr>
<tr><td>Course Description</td><td colspan="7">To impart knowledge in depth about nuclear radiation, its detection, nuclear spectrometry and related aspects</td></tr>
<tr><td>Course Objectives</td><td colspan="7">• To aware the students about the various type of nuclear radiations and their interaction with matter
• To learn various techniques for detection of radiations
• To study the nuclear spectrometry</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">After completion of this course, students would be able to:
• Understand nuclear radiation and its detection procedure, nuclear spectrometry.
• Know applications of nuclear spectrometry
• Know how to solve problems related to safety aspect of nuclear radiation
• Understand the nuclear spectroscopy and basics of nuclear medicine.</td></tr>
<tr><td colspan="8">COURSE SYLLABUS</td></tr>
</table>

Unit No.	Content of Each Unit	Hours of Each Unit
1	**Interaction of Nuclear Radiations:** Origin and energy spectra, Brief discussion of interactions of gamma rays, Electron and heavy charged particles with matter, Different types of neutron sources, Interaction of neutron with matter, Neutron detectors.	15
2	**Nuclear Radiation Detector:** Gas filled detectors; Ionization chamber, Proportional counter and GM counter, Scintillation detector, semiconductor detector for X-rays, gamma rays and charged particle detection, Radiation exposure, Biological effects of radiation, radiation monitoring	15
3	**Nuclear Spectrometry and Applications:** Analysis of nuclear spectrometric data, measurement of nuclear energy levels, spins, parities, moments, internal conversion coefficients, Angular correlation, Perturbed angular correlation, measurement of g-factor and hyperfine fields.	15
4	**Mossbauer Effect:** Positron annihilation, particle and photon induced x-ray emission, Elemental concentration analysis by charged particles and neutron activation analysis, Diagnostic nuclear medicine, Therapeutic nuclear medicine.	15

TEXT BOOKS

1. Knoll G. F., Radiation Detection and Measurement, John Wiley & Sons, 1989.
2. Singuru R. M., Introduction to experimental nuclear physics, Wiley Eastern Publications, 1987.
3. Muraleedhara V. Nuclear radiation Detection, measurement and Analysis, Narosa Publishing House, 2009.

Environmental Physics

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Environmental Physics</td><td>L</td><td>T</td><td>P</td><td>C</td><td rowspan="2">Semester:
II (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td>30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td>70 Marks</td><td colspan="3">Prerequisite of Course: 10+2 with Science</td></tr>
</table>

Course Description	This course aims to introduce students to the application of core physical concepts of the Earth system, with special focus on: atmospheric radiation, greenhouse gases, pollution, and climate change. This course will demonstrate how physics is fundamental to understand natural and human influences on climate and atmospheric composition.
Course Objective	• To understand the broad scope of problems to which the principles of environmental physics can be applied and to appreciate the commonalities that exist among widely varying systems; • To develop problem solving abilities and a critical, practical awareness ofglobal environmental change.
Course Outcomes	On completion of the course, student would be able: • To understand the concepts like energy transformations and various forms of energy, climate change and its effect on living beings • To understand the concepts like thermodynamics and its applications to various energy transformation processes: • To develop an awareness of climate change and its effects • To develop an awareness of different fossil fuels and their alternatives

COURSE SYLLABUS

Unit No.	Content of Each Unit	Hours of Each Unit

1	**Introduction to Energy:** Importance of energy in science and society. Types of energy (mechanical, heat, chemical, nuclear, electrical). Law of conservation of energy. Energy transformations. Mechanical energy: force, work, kinetic and potential energy, PE diagrams, conservation of mechanical energy, bound systems. Electricity Basics.	**15**
2	**Heat Energy and Kinetic Theory** Heat and Tem:perature. Internal Energy, Specific Heat. Ideal gas equation. Kinetic theory interpretation of pressure and temperature. Work, heat, and the first law of thermodynamics. Adiabatic lapse rate. Radiant energy. Blackbody radiation.Heat engines and the second law of thermodynamics. TheCarnot cycle. Applications of the second law to various energy transformation processes: heat pumps and refrigerators; different engine cycles. Entropy and disorder.	**15**
3	**Energy and Climate Change:** Energy balance of the Earth. Greenhouse effect. Climate feedbacks (water, clouds, ice albedo). Global Climate Models. Evidence for climate change. Paleo-climate. Climate change impacts. Climate change mitigation. Target CO_2 levels.	**15**
4	**Energy Source [Course Outcome(s):** Chemical energy. Energy in biology, photosynthesis, respiration. Energy use in the human body, energy content of food. Fossil fuels and their origin (coal, oil, natural gas). Problems with fossil fuels, greenhouse pollution, peak oil. Alternatives to fossil fuels. Alternative energy resource: Wind energy, energy from water on land, ocean energy. Biomass and other sources.	

TEXT BOOKS

1. **Sol Wieder**, An Introduction of Solar Energy for scientists and Engineers, John Wiley, United States, 1st Edition, 1982.
2. **J.T. Widell** and **J. Weir**, Renewable Energy Resources, Elbs, 1st Edition, 1988.
3. **R.N. Keshavamurthy** and **M. Shankar Rao**, The Physics of Monsoons, Allied Publishers, New Delhi, 1st Edition, 1992.
4. **Landau** & **Lifshitz**, Fluid Mechanics, Pergamon Press, UK, 2nd Edition, 2000.
5. **Egbert Boeker** & **Rienk Van Groundelle**, Environmental Physics, John Wiley, United States, 2nd Edition, 2000.
6. **J.T. Hougtyion**, The Physics of Atmosphere, Cambridge University Press, 3rd Edition, 2002.
7. **C. W. Rose**, An Introduction to the Environmental Physics of Soil, Water and Watersheds, Cambridge University Press, 1st Edition, 2004.
8. **R. A. Hinrichs** and **M. Kleinbach**, Energy, Its Use and the Environment, Brooks Cole, Stanford University Press, 4th Edition, 2005.

9. **P. Hughes**, **N. J. Mason**, Introduction to Environmental Physics: Planet Earth, Life and Climate, Taylor & Francis, France, 1st Edition, 2005.
10. **J. Monteith** and **M. Unsworth**, Principles of Environmental Physics: Plants, Animals and the Atmosphere, Elsevier, 4th Edition, Europe, 2013.
11. **K.L. Kumar**, Engineering Fluid Mechanics, S. Chand, New Delhi, 4th Edition, 2016.

Physics of Digital Photography

<table>
<tr><td rowspan="2">Scheme Version:
2024-26</td><td rowspan="2">Name of the subject:
Physics of Digital Photography</td><td>L</td><td>T</td><td>P</td><td colspan="2">C</td><td rowspan="2">Semester:
I (1st Year)</td><td>Contact hours per week: 3+1</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td colspan="2">4</td><td>Total Hours: 60=45+15</td></tr>
<tr><td rowspan="2">Subject Code:</td><td rowspan="2">Applicable to Programs:
M.Sc. Physics</td><td rowspan="2">Evaluation
(Total Marks: 100)</td><td>Internals</td><td colspan="2">30 Marks</td><td colspan="3">Examination Duration: 3 hours</td></tr>
<tr><td>End Term Exams</td><td colspan="2">70 Marks</td><td colspan="3">Prerequisite of Course: B.Sc. with Physics</td></tr>
<tr><td>Course Description</td><td colspan="8">The aim of this course is to provide a theoretical overview of the photographic imaging chain. The course is intended to serve as a link between imaging science and photographic practice.</td></tr>
<tr><td>Course Objective</td><td colspan="8">• To become proficient at the technical aspect of photographing with a digital camera.
• To develop and practice skills using digital photography tools and the Internet including emailing and posting to a web site
• To develop the habit of looking closely at the visible world around you in order to represent it in terms of aesthetics, beauty and truth. – To look at what you are seeing and to see what you are looking at.</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">On completion of the course, student would be able:
• To understand the photographic optics & methods
• To understand the basic principle of photography
• To understand the theory of exposure
• To understand about the image quality</td></tr>
</table>

COURSE SYLLABUS		
Unit No.	**Content of Each Unit**	**Hours of Each Unit**
1	**Fundamental optical formulae:** Image formation: Refraction, Gaussian optics, Lens refractive power, Magnification, Focal length, Lens focusing movement Field of view: Entrance and exit pupils, Chief and marginal rays, Angular field of view, Field of view area, Focal-length multiplier, Depth of field: Circle of confusion, Depth of field equations, Hyperfocal distance, Focus and recompose limits, distortion, Exposure: Photometry, Flux emitted into a cone, Relative aperture, f-number, Working f-number, f-stop, Natural vignetting, Photometric exposure, Exposure value, f-number for aplanatic lenses	**15**
2	**History of photography:** Pinhole Camera, Camera Obscura, Normal Human Eye and Process of Seeing-Human eye and camera, Camera principles: Compact cameras and SLR's - Working of SLR camera- Different image sensors-CCD and CMOS. Angle of view- Different types of lenses-normal lens, wide angle lens, fish eye lens, prime lens, telephoto lens. Depth of Field-Shallow depth of field, large depth of field, Depth of focus - circles of confusion	**15**
3	**Exposure strategy :** Digital output, Sensor response, Colour, Digital output levels, Dynamic range, Tonal range, Tone reproduction, Gamma, Tone curves, Histograms, verage photometry, Reflected-light metering, Average scene luminance, Exposure index, ISO speed, Standard output sensitivity, Exposure modes: Metering modes, Exposure compensation, Aperture priority (A or Av), Shutter priority (S or Tv), Program mode (P), Manual mode (M)	**15**
4	**Image quality :** Colour temperature, White balance, Color space, Lens MTF, sharpness, Signal-to-noise ratio, Different Image capturing formats: RAW, TIFF, JPEG, Storage Devices- SD card CF card, Principles of Composition: Perspective - Space (Negative and Positive), Directional lines-Golden Section and Rule of the Third, Colour	**15**

	Theory	

TEXT BOOKS
1. **Steven Heller**, A History of Photography: From 1839 to the Present 2. **Tom Ang,** Photography: The Definitive Visual History 3. **Todd Gustavson** and **George Eastman House**, Camera: A History of Photography from Daguerreotype to Digital by Understanding Exposure, Fourth Edition by BRYAN PETERSON. 4. **DK**, Digital Photography Complete Course Hardcover 5. **Fil Hunter, Steven Biver and Paul Fuqua**, Light Science & Magic: An Introduction to Photographic Lighting by Understanding Color in Photography by Bryan Peterson. 6. **Andy Rowland**, Physics of Digital Photography by (IOP Publishing).