THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF APPLIED & PURE SCIENCES (RSAPS)

DEPARTMENT OF PHYSICS

COURSE STRUCTURE & SYLLABUS
(BASED ON NATIONAL EDUCATION POLICY 2020)
FOR

B.Sc. IN PHYSICS

(4 YEARS SINGLE MAJOR)

(Syllabus of 5th, 6th, 7th & 8th Semester)

W.E.F
AY – 2023-24

STRUCTURE OF THE SYLLABUS FOR 4 YEAR UG PROGRAMME

SCHOOL NAME – ROYAL SCHOOL OF APPLIED AND PURE SCIENCES
DEPARTMENT NAME - PHYSICS
PROGRAMME NAME - B.Sc. in PHYSICS

1st SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012 M101	Mechanics	100	3	3-0-0
	PHY012 M111	Physics Lab I	100	3	0-0-6
Minor	PHY012N101	Fundamentals of Physics	100	3	3-0-0
Interdisciplinary (IDC)	IKS-1	Introduction to Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement course (AEC)	CEN982A101	Communicative English	100	1	1-0-0
	BHS982A102	Behavioral Science-I	100	1	1-0-0
Skill Enhancement Course (SEC)	PHY012S111	Physics Workshop Skills	100	3	0-0-6
Value Added Course (VAC)	VAC-1	From basket courses	100	3	0-0-6
Swayam 1	SWAYAM CODE 1	Swayam 1	100	3/4/5	
TOTAL CREDIT FOR 1st SEMESTER				**20** + 3/4/5	
2nd SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012 M201	Electricity and Magnetism	100	3	3-0-0
	PHY012 M211	Physics Lab II	100	3	0-0-6
Minor	PHY012N211	General Physics Lab I	100	3	0-0-6
IDC	IKS-2	Introduction to Indian Knowledge System – II	100	3	3-0-0
AEC	CEN982A201	Communicative English	100	1	1-0-0
	BHS982A 202	Behavioral Science-II	100	1	1-0-0
SEC	PHY012S211	Electrical Circuit and Network Skills	100	3	0-0-6
VAC	VAC-2	From basket courses	100	3	3-0-0
Swayam 2	SWAYAM CODE 2	Swayam 2	100	3/4/5	
TOTAL CREDIT FOR 2nd SEMESTER				**20** + 3/4/5	
3rd SEMESTER					

COMPONENT	COURSE CODE	COURSE TITLE	LEVEL	CREDIT	L-T-P
Major (Core)	PHY012M301	Ray and wave optics	200	4	4-0-0
	PHY012M302	Mathematical Physics-I	200	4	4-0-0
Minor	PHY012N301	Modern Physics	200	4	4-0-0
IDC	PHY012I301	IKS related to the major field of Specialization (Introduction to Astrophysics)	200	3	3-0-0
AEC	CEN982A 301 & BHS982A 302	Communicative English and Behavioral Science-III	200	2	2-0-0
SEC	PHY012S 311	Basic Instrumentation skills	200	3	3-0-0
Swayam 3	SWAYAM CODE 3	Swayam 3	200	3/4/5	
TOTAL CREDIT FOR 3rd SEMESTER				**20** + 3/4/5	
4th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M401	Thermal & Statistical Physics	200	4	4-0-0
	PHY012M402	Nuclear & Particle Physics	200	4	4-0-0
	PHY012 M411	Physics Lab III	200	4	0-0-8
Minor	PHY012N401	Atomic and Nuclear Physics	200	3	3-0-0
	PHY012N411	General Physics Lab II	200	3	0-0-6
AEC	CEN982A 401 & BHS982A 402	Communicative English and Behavioral Science-IV	200	2	2-0-0
Swayam 4	SWAYAM CODE 4	Swayam 4	200	3/4/5	
TOTAL CREDIT FOR 4th SEMESTER				**20** + 3/4/5	
5th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M501	Classical and Quantum Mechanics	300	4	4-0-0
	PHY012M502	Solid State and Mathematical Physics-II	300	4	4-0-0
	PHY012M503	Electrodynamics	300	4	4-0-0
Minor	PHY012N501	Fundamentals of Thermal Physics	300	4	4-0-0
Internship	PHY012M521	Internship	300	4	4-0-0
TOTAL CREDIT FOR 5th SEMESTER				**20**	
6th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**

Major (Core)	PHY012M601	Electronics	300	4	4-0-0
	PHY012M602	Advanced Classical and Quantum Mechanics	300	4	4-0-0
	PHY012M603	Atomic & Molecular Physics	300	4	4-0-0
	PHY012M611	Physics Lab IV	300	4	0-0-8
Minor	PHY012N601	Physical Optics	300	4	4-0-0
TOTAL CREDIT FOR 6th SEMESTER				**20**	
7th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M701	Theory of relativity	400	4	4-0-0
	PHY012M702	Astronomy	400	4	4-0-0
	PHY012M703	Mathematical Physics-III	400	4	4-0-0
	PHY012M704	Waves Oscillation & Sound	400	4	4-0-0
Minor	PHY012N701	Basics of electronics	400	4	4-0-0
TOTAL CREDIT FOR 7th SEMESTER				**20**	
8th SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	PHY012M801	Methods of selected instruments used Physical Sciences Research	400	4	4-0-0
	PHY012M802	Research Methodology	400	4	4-0-0
Project / Dissertation	PHY012M821	Research Project	400	12	0-0-0
For the students who are not eligible for the Research Project*					
Or 400 level advanced course Core (in lieu of Project / Dissertation)	PHY012M803	Fiber Optics and Basic of Laser	400	4	4-0-0
	PHY012M804	Plasma and space physics	400	4	4-0-0
	PHY012M805	Nanophysics	400	4	4-0-0
TOTAL CREDIT FOR 8th SEMESTER				**20**	

Level: Semester V

Course Level: C-501

Name of the Subject: Classical and Quantum Mechanics

Type of Course: Major

Subject Code: PHY012M501 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r different constraints involved in the motion of a physical system, photoelectric effect, operators etc.	**BT 1**
CO 2	**Understand** the basic concepts of central forces, Lagrangian and Hamlitonian dynamics, Compton effect, de-Broglie hypothesis, Schrödinger equation etc.	**BT 2**
CO 3	**Apply** Lagrangian and Hamlitonian dynamics to a few physical systems, Schrödinger equation in closed systems like particle in box, quantum harmonic oscillator etc.	**BT 3**
CO 4	**Analyze** commutation relation among position and momentum operators, different components of angular momentum operator, constructive and destructive operators of quantum harmonic oscillator etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Constraints, generalized co-ordinates; principle of virtual work, D' Alembert's principle and Lagrange's equations of motion; applications of Lagrangian formulations to atwood machine, simple pendulum, bead sliding on rotating wire, compound pendulum, linear harmonic oscillator	**15**
II.	Hamilton's principle; Lagrange's equations from Hamilton's principle; Hamilton's canonical equations of motion; applications of Hamilton's equations to simple problems; Poisson brackets. Concept of Central Force and Kepler's laws of planetary motion.	**15**
III.	Inadequacies of Classical Physics, Black-body radiation, Plank's Law, Photoelectric effect, Compton effect, de Broglie hypothesis, Wave-particle duality of radiation and matter, Schrödinger equation (time-dependent and time- independent); Physical interpretation of wave function; Born interpretation; Equation of continuity; Probability density and Probability current density. Heisenberg's Uncertainty Principle; Operator, Expectation value of a physical variable or operator, Application of Schrodinger equation to one-dimensional problems; Particle in a box; linear harmonic oscillator; square well potentials; potential step; barrier potential; tunneling effect.	**15**

IV.	Different types of operators: linear, Hermitian, unitary etc. Commutator of two operators; Commutator algebra; Eigen values and Eigen functions of an operator; Commutator or position and momentum operators' Angular momentum operator in quantum mechanics; commutation relations of the three components; Commutation relation between position and angular momentum, between linear momentum and angular momentum	**15**
Total		**60**

Textbooks:

1. *Classical Mechanics*; Goldstein H., Narosa Publishing House, 3rdEd., New Delhi,2011.
2. *Introductory Quantum Mechanics; Liboff R.L., Pearson Education, 4th Ed., 2007, New Delhi.*
3. *Basics of Quantum Mechanics, Ajoy Ghatak, Mc. Millan Publishing, 2009*

Reference Books:

1. Rana &Yoag, *Classical Mechanics,* Tata McGraw-Hill Publishing Company Limited, 1st Ed., New Delhi,2017.
2. Upadhaya J. C, *Classical Mechanics,* Himalaya Publishing House, 3rd Ed., Mumbai,2017
3. L.I. Schiff, Bandhyopadhay J.; Quantum Mechanics, McGraw Hill Education; 4th Ed., 2017, New Delhi

NPTEL LINK: https://archive.nptel.ac.in/courses/122/106/122106027/
NPTEL LINK: https://archive.nptel.ac.in/courses/115/101/115101107

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester V

Course Level: C-502

Name of the Subject: Solid state and Mathematical Physics

Type of Course: Major

Subject Code: PHY012M502 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** lattice, X-ray diffraction, line integral, Gauss divergence theorem, Stokes' theorem etc.	**BT 1**
CO 2	**Understand** unit cell, Miller indices, band theory of solid, the complex variables, analytic function etc.	**BT 2**
CO 3	**Apply** K-P model, Hall Effect, residue theorem to solve complex integrals.	**BT 3**
CO 4	**Analyze** Superconductivity, Meissner effect, Taylor's series method, method of separation of variables, etc to solve problems.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Crystal Lattices and Unit Cells:** Bravais lattices, primitive and conventional unit cells, crystal systems. Miller Indices and X-ray Diffraction: Bragg's Law, Lattice Vibrations and Phonons, dispersion relations for mono atomic and diatomic chains. Heat Capacity of Solids: Classical theory (Dulong-Petit law), Einstein and Debye models	**15**
II.	**Electronic Properties of Solids:** Free Electron Theory: Drude model, electrical and thermal conductivity in metals. Fermi energy, density of states. Band Theory of Solids: Bloch's theorem, Kronig-Penney model (Discussion only), energy bands in metals, semiconductors, and insulators. Hall Effect: Hall coefficient, applications. Fundamentals of Superconductivity: Meissner effect, critical temperature, type-I and type-II superconductors. BCS Theory: Cooper pairs, Josephson effect	**15**
III.	**Integration of vectors:** Understanding of line integral, surface integral and volume integrals of vectors and their applications to simple physical problems. Analysis of Gauss' divergence theorem, Green's theorem, Stokes' theorem and problems. **Differential equations:** Concept of order and degree of differential equation, Second order linear differential equation and its solution as sum of complementary function (C.F.) and particular integral (P.I.). Homogeneous and Non-homogeneous differential equation, series solution of differential equation: Frobenius method. Partial differential equation. Method of separation of variables. Laplace equation, wave equation and their solutions. Taylor series method, Euler method, Runge- kutta methods to obtain the numeric values from ordinary differential equation.	**15**

IV.	**Complex variables:** Understanding of Algebraic notation (z), Argand diagram, modulus and argument, powers of iota (1), complex conjugate, complex numbers in cartesian, polar, and exponential forms, Euler's formula, De-Moiver's theorem. Functions of complex variable, concept of neighbourhood, continuity and differentiability of complex function. Analysis of analytic function, Cauchy Reimann conditions in cartesian and polar form and its application to analyze analyticity of different complex functions, Evaluation of related problems, concept of singular point, poles of order 'n'. Cauchy integral theorem. Cauchy integral formula and related problems. Methods to find residue, Cauchy's residue theorem. Complex integrals: Simple contour integrals, integration round unit circle, and complex function in the -ve infinte to +ve infinte limits.	**15**
Total		**60**

Text:

1. Mathematical Physics by Das H.K. S. Chand publishing 8th edition(2018).
2. Mathematical Physics by George B. Arfken,Elesvier Publisher7th edition(2012).

Reference Books:

1. Rajput and Yogprakash Mathematical Physics, Pragati Prakashan, Meerut(2014).

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc21_ma27/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester V

Course Level: M503

Name of the Subject: Electrodynamics

Type of Course: Major

Subject Code: PHY012M503 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the student in understanding the relation between charge and its field, characteristics of magnetic force and time varying e.m.f. It will also help in analysing the interaction between e.m. wave and matter.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Remember** determining factors of electromagnetic forces and fields.	**BT 1**
CO 2	**Understand** the relationship between electric and magnetic fields.	**BT 2**
CO 3	**Apply** the concepts of space and time varying electromagnetic fields.	**BT 3**
CO 4	**Analyze** the behavior of electromagnetic wave in a matter.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Concept of electric potential, electric potential energy of single charge and a charge distribution; surface charge and the force on the surface of a conductor, Laplace's equation.	**15**
II.	Force on a moving charge and current carrying conductor in a magnetic field; force between two current-carrying wires, general expressions for fields due to current densities, curl and divergence of the magnetic field, Ampere's law. Motional electromotive force; Faraday's law, electromagnetic field equation in integral and differential form, displacement current, Maxwell's equations, energy conservation law, Poynting theorem.	**15**
III.	Origin and characteristics of electromagnetic wave; monochromatic plane wave equation in free space and conducting medium; reflection and refraction of plane electromagnetic wave for normal and oblique incidence, Snell's law.	**15**
IV.	Macroscopic electrodynamics: macroscopic Maxwell equation, averaged sources applications of macroscopic electrodynamics, Electrostatics in the presence of matter, Magnetostatics in the presence of matter Relativistic electrodynamics: magnetism as a relativistic phenomenon, transformation of fields, field tensor, electrodynamics in tensor notation, relativistic potential.	**15**
Total		**60**

Text:

1. Introduction to Electrodynamics, Griffiths D.J., PHI, 4th Ed., 2016, New Delhi
2. Electricity and Management, Tayal D. C., Himalaya Publishing House, 4th ED., (Revised), 2014, Mumbai

Reference Books:

1. Chakraborty B., Principles of Electrodynamics, Books & Allied Ltd., 1st Ed., 2010, Kolkata

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc22_ph46/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester V

Course Level: N 501

Name of the Subject: Fundamentals of Thermal Physics

Type of Course: Minor

Subject Code: PHY012N501 **Scheme of Evaluation: Theory**

L-T-P-C:4-0-0-4 **Total credit: 4**

Course Objectives: To make the students understand the basics of Thermal Physics and it's applications

Upon completion of this course, students will be able to:		
Sl. No.	**Course Outcome**	**Blooms Taxonomy Level**
CO-1	**Remember:** Fundamental concepts of Thermodynamics, laws of thermodynamics, Kinetic theory of gases and Entropy. The ideas of Heat engine.	**BT 1**
CO-2	**Understand:** Temperature and Free energies etc.The ideas of specific heat of gas, change of states, Black body radiation.	**BT 2**
CO-3	**Apply:** the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.	**BT 3**
CO-4	**Analyze:** Theory of radiation and its applications. Solve problems in some physical systems.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Hours**
I.	**Thermodynamic Description of system**: Zeroth Law of thermodynamics and temperature. Laws of Thermodynamics, First law and its consequences. Isothermal and adiabatic processes. Reversible, irreversible processes. Second law and entropy. Carnot's cycle and theorem. Entropy changes in reversible and irreversible processes. Third law of thermodynamics, Unattainability of absolute zero.	**15**
II.	**Thermodynamic Potentials:** Concept of Ideal or Perfect Gas. Degrees of Freedom. Enthalpy, Gibbs, Helmholtz and Internal Energy functions. Specific heat of Mono, Di, and Polyatomic gas, Change of State. Van der Walls' equation of State. Maxwell's relations and applications. Joule-Thompson Effect. Clausius- Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V.	**15**
III.	**Kinetic Theory of Gases:** Derivation of Maxwell's law of distribution of velocities and its experimental verification. Mean free path. Law of equipartition of energy (no derivation) and its	**15**

	applications to specific heat of gases; mono-atomic and diatomic gases.	
IV.	**Theory of Radiation:** Blackbody radiation. Spectral distribution. Concept of Energy Density. Derivation of Planck's law. Deduction of Wien's distribution law. Rayleigh- Jeans Law. Stefan Boltzmann Law and Wien's displacement law from Planck's law.	**15**
Total		**60**

Text:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Heat and Thermodynamics, M.W. Zemasky and R. Dittman, 1981, McGraw Hill

Reference Books:

1. *Lokanathan S. and Gambhi R.S.; Statistical and Thermal Physics- An introduction, P.H.I., 1st Ed., 2008, New Delhi*
2. *Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W. Sears and*
3. *G.L.Salinger. 1988, Narosa*

Additional Readings:

1. *University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.*
2. *Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.*

NPTEL LINK: *https://onlinecourses.nptel.ac.in/noc23_ph11/preview*

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs.	0	30 hrs.

Level: Semester VI

Course Level: C-601

Name of the Subject: Electronics

Type of Course: Major

Subject Code: PHY012M601 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will provide the students with the fundamental skills to understand the basics of semiconductors and components, apply, analyze and evaluate different biasing techniques to operate transistors, FET, MOSFET and operational amplifier in different modes.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r basics of semiconductors & devices and their applications in different areas.	**BT 1**
CO 2	**Understand** the principles of semiconductor devices and their applications.	**BT 2**
CO 3	**Apply** logic gates, flip flops in building block of digital systems.	**BT 3**
CO 4	**Analyze** output in different operational modes of different semiconductor devices.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Semiconductor and Transistors**: Concept of Bandgap in semiconductor, Types of Semiconductors, Introduction to P-N junction Diode and V-I characteristics, Biasing of PN junction, Load line analysis, Types of diode (Zener, LED, Tunnel etc),Transistor and its characteristics (Introduction to BJT), Transistor as an amplifier and switch, Half wave and Full-wave rectifiers, filters.	**15**
II.	**Operational amplifier and its applications:** Introduction to operational amplifiers, Ideal operational amplifier, Characteristics of OP-AMP, OP-AMP in open loop and closed loop configuration, op-amp with negative feedback, study of practical op-amp IC 741, inverting and non-inverting amplifier, OP-AMP as adder, subtractor, differentiators, integrators, logarithmic amplifier, Applications of OM-AMP, Solution of differential equations, Filters and noise reduction, Differential amplifier, Concept of Feedback amplifier.	**15**
III.	**Digital Electronics**: Difference between analog and digital signals, Number systems, Boolean algebra and Logic gates, Laws of Boolean algebra, De Morgan's theorem, Reduction Boolean expression, Karnaugh map, Simplification using K-map, Flip-Flops, Registers, Counters, comparators, A/D and D/A converters, Multiplexer, Demultiplexer.	**15**
IV.	**Transistor Oscillators and multivibrators:** Introduction to Feedback oscillators, Hartley oscillator, Colpitt oscillator, Phase shift oscillator, Barkhausen's criteria for oscillation, R-C oscillator and Wein bridge oscillator, Multivibrators, astable, mono-stable, bistable and multi-vibrators RC-timing circuits.	**15**
Total		**60**

Text Book:

1. Handbook of Electronics; Gupta & Kumar, Pragati Prakashan, 38th Edition 2012.
2. R.P. Jain , "Modern Digital Electronics" , Tata Mc Graw Hill, 3rd Edition, 2007.

Reference Book:

1.Talukdar P. H.; Digital Logic and System Design, Mani Manik Prakash, 1st Ed., 2016, Guwahati.
2.Chattopadhyay D.; Electronics: Fundamentals & Applications; New Age International, 1st Ed., 2010, New Delhi.

NPTEL LINK: https://nptel.ac.in/courses/122106025

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VI

Course Level: C-602

Name of the Subject: Advanced Classical and Quantum Mechanics

Type of Course: Major

Subject Code: PHY012M602 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r different Canonical Invariants of a physical system, different operators and commutation relations etc.	**BT 1**
CO 2	**Understand** the concepts of Hamilton-Jacobi Method, hydrogen atom problem, approximation methods	**BT 2**
CO 3	**Apply** Canonical Transformations to a few physical systems, spherical harmonics, eigen value and eigen function in case of hydrogen atom problem.	**BT 3**
CO 4	**Analyze** different approximation methods in ideal quantum mechanical systems, etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Equations of Canonical Transformations; Examples of Canonical Transformations; Poisson Brackets and Other Canonical Invariants, Conservation Theorems in Poisson Bracket Formulation, Infinitesimal Canonical Transformations; Angular Momentum Poisson Bracket Relations; Liouville's Theorem	**15**
II.	Hamilton-Jacobi Equation; Solution of Harmonic Oscillator Problem using Hamilton-Jacobi Method; Separation of Variables in the Hamilton-Jacobi Equation; Action-Angle Variables in 1-D Systems; Kepler Problem in Action-Angle Variables	**15**
III.	Eigen values and Eigen functions of angular momentum operator; Ladder operator and their applications, Angular momentum operator in spherical polar coordinates; particle in a central field, application of Schrodinger equation to hydrogen atom.	**15**
IV.	approximation methods in quantum mechanics; Time dependent perturbation theory for a non-degenerate case and for a degenerate case, Stark effect, Zeeman effect, Variational method, application to the helium atom, the WKB approximation.	**15**
Total		**60**

Textbooks:

4. *Classical Mechanics*; Goldstein H., Narosa Publishing House, 3rdEd., New Delhi,2011.
5. *Introductory Quantum Mechanics; Liboff R.L., Pearson Education, 4th Ed., 2007, New Delhi.*

Reference Books:

4. Rana &Yoag, *Classical Mechanics,* Tata McGraw-Hill Publishing Company Limited, 1st Ed., New Delhi,2017.
5. Upadhaya J. C, *Classical Mechanics,* Himalaya Publishing House, 3rd Ed., Mumbai,2017

6. L.I. Schiff, Bandhyopadhay J.; Quantum Mechanics, McGraw Hill Education; 4th Ed., 2017, New Delhi

NPTEL LINK: https://archive.nptel.ac.in/courses/122/106/122106027/
NPTEL LINK: https://archive.nptel.ac.in/courses/115/101/115101107

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VI

Course Level:

Name of the Subject: Atomic and Molecular Physics

Type of Course: Major

Subject Code: PHY012M603 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

To develop basic foundations in atomic models and grasp the concept of energy configuration of electrons in atoms and molecules. And to understand the transition spectrums of electronic, vibrational and rotational energy levels.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Remember** the atomic structures, electrons motion in an atom and energy, momentum and quantum numbers associated with them.	**BT 1**
CO 2	**Understand** problems related to atomic and molecular transitions and corresponding spectrums.	**BT 2**
CO 3	**Apply** the knowledge to identify allowed transitions and measure the wavelength of corresponding emitted spectrum.	**BT 3**
CO 4	**Analyse** the couplings of angular momentum vectors and transition rules in atoms and molecules.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Thomson Model, Rutherford alpha particle finding experiment and nuclear atom model. Limitation of the model. Bohr atom model. Hydrogen like atom spectra. Correspondence principle.	**15**
II.	Sommerfeld model (elliptical orbit and relativistic correction), Vector atom model (Space quantization and spinning electron). Quantum number associated with vector atom model. Basics of Spin – Orbit interaction, Spectral term, Fine structure of hydrogen atom, Stern- Gerlach experiment.	**15**
III.	Spectra of alkali elements: general features, spectral series, spectra of sodium atom. Basics of electronic transitions. X-ray spectra: continuous spectra, Duane-Hunt law, characteristics lines, Mosley law, Absorption spectra, fine structure.	**15**
IV.	Molecular Spectra: The Born-Oppenheimer approximation, rotational spectra, rigid diatomic molecule, rotational energy of the diatomic molecule, simple harmonic oscillator, and Anharmonic oscillator.	**15**
Total		**60**

Text:

1. Fundamentals of molecular spectroscopy – Colin N. Banwell and Elaine M. Mccash: McGraw-Hill College (2016).
2. Elements of Spectroscopy: Atomic, Molecular and Laser Physics - Gupta, Kumar and Sharma, Pragati Prakashan, Meerut, (2016).

Reference Books:

1. Beiser. A: Concept of Modern Physics; Publisher: McGraw Hill Education (2009).
2. White: Introduction to Atomic spectra; Publisher Mc graw-hill book company (2016).
3. Raj Kumar: Atomic and Molecular Spectra: Laser; Publisher: Kedarnath Ramnath (2012).
4. Gupta. S.L., V. Kumar, R.C. Sharma: Elements of Spectroscopy; Pragati Prakashan. (2016).
5. Rajam J.B: Atomic physics; Publisher: S. Chand (2010)

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc25_ph04/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VI

Course Level: M-611

Name of the Subject: Physics Lab IV

Type of Course: Major

Subject Code: PHY012M611 **Scheme of Evaluation: Practical**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course objectives: This course will help the students to understand, apply, analyze, and evaluate different experiments in Physics

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Find** different physical device	**BT 1**
CO 2	**Demonstrate** different mechanisms like polarization of light, damping etc.	**BT 2**
CO 3	**Apply** different methods in physics experiments.	**BT 3**
CO 4	**Analyse** different experimental results and errors involved in the experiment	**BT 4**

List of experiments:

1. Measurement of Planck's constant.
2. To verify the Law of Malus for Plane Polarized light
3. Determination of the wavelength of a diode laser using Michelson interferometer.
4. Forbidden Energy Gap from P-N junction
5. Study of the characteristics of a GM tube
6. Photo-diode Characteristics
7. Solar-Cell Characteristics.
8. To study the RC characteristics using an Oscilloscope and Multimeter.

Text

1. *B.Sc. Practical Physics* C.L. Arora, S. Chand 20th edition (2010).
2. *B.Sc. Practical Physics* P. R. Sashi Kumar, Prentice Hall India learning (2011).

References:

Mazumdar K.G. and Ghosh B.*A Textbook on Practical Physics* Sreedhar Publishers16th edition(2012)

NPTEL LINK: https://archive.nptel.ac.in/courses/115/105/115105110

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
o	60 hrs	30 hrs

Level: Semester VI

Course Level: N 601

Name of the Subject: Physical Optics

Type of Course: Minor

Subject Code: PHY012N601 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credit: 4**

Course Objectives: To make the students understand the basics of Physical Optics and its applications

Upon completion of this course, students will be able to:		
Sl. No.	**Course Outcome**	**Blooms Taxonomy Level**
CO-1	**Remember:** Fundamental wave properties and superposition of waves, interference, diffraction, polarization and its significance.	**BT 1**
CO-2	**Understand:** Understand and apply wave theory. Use Huygens' principle to describe reflection and refraction.	**BT 2**
CO-3	**Apply:** Apply the principle of superposition to interference effects. Demonstrate Young's Double-slit experiment and thin-film interference. Use Malus's law and Brewster's law to solve polarization-related problems	**BT 3**
CO-4	**Analyze:** Analyse the energy and momentum properties of light waves; Calculate the diffraction patterns from single, double-slits and a diffraction grating with applications.	**BT 4**

COURSE OUTLINE:

Modules	Topics / Course content	Hours
I.	**Wave Nature of Light:** Basic wave properties; Huygens' Principle; Reflection and Refraction using Huygens' principle; Superposition of Waves; Phase and Group Velocity; Coherence (Temporal and Spatial) and path difference; Energy and momentum of light waves; Light as an electromagnetic wave; Maxwell's equations.	**15**
II.	**Interference:** Principle of superposition; Constructive and destructive interference; Interference by Division of Wavefront, Young's Double-Slit Experiment, Fresnel's Biprism; Interference by Division of Amplitude, Thin Films, Newton's Rings, Michelson Interferometer; Interference in Wedge-Shaped Films; Optical Path Difference and Fringe Width.	**15**
III.	**Diffraction:** Fresnel and Fraunhofer Diffraction; Single-Slit and Double-Slit Diffraction; Diffraction Grating and Resolving Power; Circular Apertures and Airy Disk; Zone Plates.	**15**
IV.	**Polarization:** Plane, Circular, and Elliptical Polarization; Malus's Law and Brewster's Angle; Double Refraction (Birefringence); Nicol Prism; Wave Plates (Quarter and Half-Wave Plates); Optical Activity	**15**

	and Fresnel's Laws; applications of polarization.	
Total		**60**

Text:

1. Fundamental of Optics; Jenkins F.A. and White H.E.: McGraw Hill, 4t edition, 2011.
2. M. Born and E. Wolf (1999). Principle of Optics. Cambridge: Cambridge University Press.

Reference Books:

4. Ghatak A.K, Optics, 2014. McGraw Hill Education; 5th edition2017.

Additional Readings:

1. Arthur Schuster, An Introduction to the Theory of Optics, London: Edward Arnold, 1904.

2. Nader El-Bizri (2005), A Philosophical Perspective on Alhazen's Optics, Arabic Sciences and Philosophy. 15 (2): 189–218.

NPTEL LINK: *https://archive.nptel.ac.in/courses/115/107/115107131/*

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs.	0	30 hrs.

Level: Semester VII

Course Level:

Name of the Subject: Theory of

relativity

Type of Course: Major

Subject Code: PHY012M701 **Scheme of Evaluation: Theory L-T-P-C: 4-1-0-3**

Total credits: 4

This course emphasis to enhance the understanding of the basics of Relativity with respect to space and time, to impart the concept of different frame of references, to familiarize the understanding of Newtonian relativity, Galilean Transformation equations and special theory of Relativity and to impart the elementary concept of General Theory of Relativity.

Course Outcomes:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the concept of space, time and mass, frame of reference, Newtonian relativity, Michelson-Morley experiment, the elementary concept of General Theory of Relativity.	**BT1**
CO2	Understand the Postulates of special theory of Relativity, Lorentz transformation, Doppler Effect, Space-time diagram, General Theory of Relativity (Elementary).	**BT2**
CO3	Apply the concepts of length contraction and time dilation to solve problems.	**BT3**
CO4	Analyze the special and general theory of relativity.	**BT4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Concept of space, time and mass in Newtonian mechanics, frame of reference, inertial frame and non-inertial frame, Newtonian relativity, Galilean Transformation equations, the ether hypothesis, the Michelson-Morley experiment, explanation of the negative result.	**15**
II.	Constancy of speed of light, Postulates of special theory of Relativity, Lorentz transformation equations-its derivation, Inverse Lorentz transformation, Length contraction and Time dilation with illustrations, the Twin Paradox, Relativity of Simultaneity.	**15**
III.	Relativistic addition of velocities, variation of mass with velocity, mass-energy equivalence, relativistic formula for kinetic energy, unified mass unit, relationship between the total energy, the rest energy and the momentum, Relativistic Doppler Effect.	**15**
IV.	Space-time diagram, Minkowski's four-dimensional space-time continuum, world- line, world-point, geodesic, four vectors, four velocity, four momentum, four force, General Theory of Relativity (Elementary), effect of gravitational field on a ray light, gravitational red shift.	**15**
Total		**60**

Text Book:

1. *Introduction to special relativity*, Robert Resnick, John Wiley & Sons, Canada, Limited, 2007.
2. *Fundamentals of special and general relativity*, K.D. Krori, Publisher, PHI Learning Pvt. Ltd., 2010.

Reference Books:

1. Edwin F. Taylor and John Archibald Wheeler, *Spacetime Physics: Introduction to Special Relativity, 2nd ed.*, W. H. Freeman & Company, 1992.
2. Bernard F. Schutz, *A First Course in General Relativity* Cambridge University Press, 1985.

NPTEL LINK: https://nptel.ac.in/courses/115/101/115101011

Level: Semester VII

Course Level: C-702

Name of the Subject: Astronomy

Type of Course: Major

Subject Code: PHY012M702 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:
Astrophysics is the physics of the stars. Therefore this course is intended to introduce the theoretical concept for a clear understanding of the astronomical phenomena.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r theoretical and practical aspects of modern observational astronomy, Photometry, spectroscopy, stellar classification, detectors, and basic information of telescopes.	**BT 1**
CO 2	**Understand** the fundamentals in the Astrophysics like the classification of stars, stellar evolution, interstellar matter, galaxies etc.	**BT 2**
CO 3	**Apply** knowledge of astrophysics to practical application of observational techniques.	**BT 3**
CO 4	**Analyze** and evaluate astrophysical calculations of fundamental character.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I	**Basics of Astronomy**: Evolution of Astronomy, The celestial sphere, Altitude and Azimuth, Declination and hour-angle, coordinate systems and transformation equations. Concept of time — solar time and sidereal time. Magnitude scales, apparent, absolute, and instrumental magnitudes. Measuring stellar distance method parallax and other methods to determine stellar distances, HR Diagram, Color Index, Spectral Class.	**15**
II	**Telescopes and Detectors**: Different types of astronomical telescopes, Mounting of telescope, Radio Telescope, Space based telescope, Astronomical Spectrograph, Photographic Photometry, Detectors, Radiation theory: Equation of radiative transfer — concepts of flux, intensity, and temperature. Formation of emission and absorption lines, limb darkening.	**15**
III	**Stars**: Formation of stars, Evolution of stars, Compact stars (White dwarf, Neutron star, Black Hole), Degenerate stars, mass–radius relation and Chandrasekhar mass limit, Jeans criterion, Integral theorems of hydrostatic equilibrium of stars, Transport of energy inside a star, Binary stars, . Nucleosynthesis – hydrogen burning (pp chain and CNO cycle), triple alpha reaction.	**15**
IV	**Galaxies and Universe:** : The Milky way Galaxy, Dark Matter, Kinematics, Hubble classification scheme for external galaxies, Normal galaxies and AGNs, Unified model, Basics of X-ray	**15**

	astronomy, black holes, and gamma ray bursts, Hubble's law, nucleo-synthesis, Cosmic Microwave Background radiation, Elementary ideas on structure formations	
	Total	**60**

Text:

1. An Introduction to Astrophysics; Baidyanath Basu, Prentice Hall Publication, 2nd Ed.,2013, New Delhi
2. An Introduction to Astronomy and Astrophysics, Pankaj Jain, CRC Press; 1st edition (8 April 2015)

References:

1. 1.V.B.Bhatia; Text Book on Astronomy and Astrophysics with elements of cosmology, Narosa Publishing House, 2nd Ed.,2001, New Delhi
2. 2.K. D. Abhayankar; Astrophysics: Stars and Galaxies, Abe Books,1st Ed., 2002, Hyderabad

NPTEL LINK:https://onlinecourses.nptel.ac.in/noc23_ph21/preview

Level: Semester VII

Course Level: C-703

Name of the Subject: Mathematical Physics III

Type of Course: Major

Subject Code: PHY012M703 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** vector algebra, complex variable, analytic function, Legendre polynomial etc.	**BT 1**
CO 2	**Understand** the concept of homogeneous and non-homogeneous differential equation, Green's function etc.	**BT 2**
CO 3	**Apply** different mathematical technique to solve physical problems.	**BT 3**
CO 4	**Analyze** tensors, Caley-Hamilton theorem etc Bessel's function, Laplace transform, Wronskian etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of base; Eigenvalues and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors, covariant and contravariant tensor, mixed tensor of different rank, algebra in tensor analysis: addition, subtraction, outer multiplication, contraction, inner multiplication, quotient law.	**15**
II.	Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable: single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals, Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Classification of singularities; Residue theorem and evaluation of some typical real integrals using this theorem.	**15**
III.	Theory of second order linear homogeneous differential equations Singular points: regular and irregular singular points; Frobenius method. Linear independence of solutions: Wronskian, second solution. Sturm-Liouville's theory; Hermitian operators; Completeness. Inhomogeneous differential equations: Green's functions	**15**

IV.	Special functions Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions., generating function Integral transforms Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of Derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.	**15**
Total		**60**

Text:

1. Mathematical Physics by Das H.K. S. Chand publishing 8th edition(2018).
2. Mathematical Physics by George B. Arfken,Elesvier Publisher7th edition(2012).

Reference Books:

1. Rajput and Yogprakash Mathematical Physics, Pragati Prakashan, Meerut(2014).

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc21_ma27/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	0	30 hrs

Level: Semester VII

Course Level: C-704

Name of the Subject: Wave , Oscillation and sound

Type of Course: Major

Subject Code: PHY012M704 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r periodic motion, simple harmonic motion, vibration of string, ultrasonic waves etc	**BT 1**
CO 2	**Understand** the basic concepts of phase and group velocity, differential equation of wave motion, Doppler's effect etc.	**BT 2**
CO 3	**Apply** different types of vibration in different physical system like mass-spring system, strings. Apply concept of sound to calculate velocity of sound in air, intensity of sound etc.	**BT 3**
CO 4	**Analyze** Lissajous' figures, differential equation of wave motion, Sabine's formula, Kundt's tube etc., Reverberation effect, etc.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Simple harmonic motion:** Periodic motion, Simple harmonic motion, Characteristics S.H.M., Vibration of simple spring's mass system, Free Vibrations, Damped and forced vibrations, Resonance. **Superposition of waves:** Principle of superposition of waves, Superposition of two waves, Interference of waves, Beats, Stationary waves, Lissajous' figures, Group and phase velocity.	**15**
II.	**Wave Motion:** Types of wave motion, Sound as wave, Phase velocity (wave velocity) and particle velocity, Linear equation of plane progressive wave motion in one and three dimensions, Instantaneous and average energy of one dimensional wave, Differential equation of wave motion. **Vibration of strings:** Transverse vibration of string, Wave equation in linear approximation, Eigen values and eigen functions of pluck and stuck string	**15**
III.	Velocity of Sound: Velocity of longitudinal waves in a gaseous medium, Calculation of velocity of sound in air, Effect of pressure, temperature and humidity on the speed of sound, Kundt's tube, Application of Kundt's tube. Doppler's effect, Application of Doppler's principle.	**15**

IV.	**Sound:** Musical sounds and noise, characteristics of musical sounds, Intensity of sound, IV Acoustics of buildings, Reverberation and time of reverberation, Sabine's formula for 12 reverberation time, Absorption coefficient and its measurement, Transmission of sound and transmission loss. **Ultrasound:** Ultrasonic waves, Production of ultrasonic waves, Detection of ultrasonics, Properties and application of ultrasonic waves.	**15**
Total		**60**

Text Book:

1. Oscillations, Waves and Acoustics; P.K. Mittal, Dreamtech Press (1 September 2019)

Reference Book:

1. N Bajaj; The Physics of Waves and Oscillations, McGraw Hill Education (1 July 2017)
2. KAKANI S.L.; WAVES OSCILLATIONS AND ACOUSTICS, CBS; 2nd edition (1 January 2018)

NPTEL LINK: https://onlinecourses.nptel.ac.in/noc19_ph18/preview

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VII

Course Level: N701

Name of the Subject: Basics of Electronics

Type of Course: Minor

Subject Code: PHY012N701 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objectives:

This course will provide the students with the fundamental skills to understand the basics of semiconductors and components, apply, analyze and evaluate different biasing techniques to operate transistors, FET, MOSFET and operational amplifier in different modes.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r basics of semiconductors & devices and their applications in different areas.	**BT 1**
CO 2	**Understand** the principles of semiconductor devices and their applications.	**BT 2**
CO 3	**Apply** logic gates, flip flops in building block of digital systems.	**BT 3**
CO 4	**Analyze** output in different operational modes of different semiconductor devices.	**BT 4**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	**Semiconductor and Transistors**: Concept of Bandgap in semiconductor, Types of Semiconductors, Introduction to P-N junction Diode and V-I characteristics, Biasing of PN junction, Types of diode (Zener, LED, photodiode, etc),Transistor and its characteristics, Transistor as an amplifier and switch, rectifiers.	**15**
II.	**Operational amplifier and its applications:** Introduction to operational amplifiers, Ideal operational amplifier, Characteristics of OM-AMP, op-amp with negative feedback, inverting and non-inverting amplifier, OM-AMP as adder, subtractor, differentiators, integrators, Filters and noise reduction, Differential amplifier.	**15**
III.	**Digital Electronics**: Difference between analog and digital signals, Number systems, Boolean algebra and Logic gates, Laws of Boolean algebra, De Morgan's theorem, Reduction Boolean expression, Karnaugh map, Flip-Flops, Registers, Counters, comparators, A/D and D/A converters.	**15**
IV.	**Transistor Oscillators and multivibrators:** Introduction to Feedback oscillators, Hartley oscillator, Phase shift oscillator, R-C oscillator and Wein bridge oscillator, Concept of Multivibrators, RC-timing circuits.	**15**
Total		**60**

Text Book:

1. Integrated Electronics; Jacob Millman, Christos Halkias and Chetan D. Parikh, McGraw Hill Education; 2nd edition (1 July 2017).

2. Handbook of Electronics; Gupta & Kumar, Pragati Prakashan, 38th Edition 2012.
3. R.P. Jain , "Modern Digital Electronics", Tata Mc Graw Hill, 3rd Edition, 2007.

Reference Book:

1.Talukdar P. H.; Digital Logic and System Design, Mani Manik Prakash, 1st Ed., 2016, Guwahati.
2.Chattopadhyay D.; Electronics: Fundamentals & Applications; New Age International, 1st Ed., 2010, New Delhi.

NPTEL LINK: https://nptel.ac.in/courses/122106025

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VIII

Course Level:

Name of the Subject: Methods of selected instruments used in physical science

Type of Course: Major

Subject Code: PHY012M801 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-3 **Total credits: 4**

Course Objectives:

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Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Understand** the **principles** and **working mechanisms** of various instruments used in physics research and material characterization.	**BT 2**
CO 2	**Apply** and **calibration the** spectroscopic, microscopic, and thermal analysis instruments.	**BT 3**
CO 3	**Analyze**the and interpret **experimental data** from various characterization techniques.	**BT 4**
CO 4	**Develop** a strong foundation for **advanced research** in various field of experimental physics.	**BT 5**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Role of Instruments in Physics Research**:** Importance of material characterization, Basic concepts of accuracy, precision, and sensitivity. Calibration and Data Acquisition**:** Basics of calibration and measurement: Noise reduction. Error calculations and statistical analysis (Technical aspects). Computer simulation techniques and their uses in theoretical research.	**10**
II.	X-ray Spectroscopy (XPS & XRF) Principles and applications in determining the composition and oxidation state of materials. UV-Visible and FTIR Spectroscopy**:** Principles and applications. Raman Spectroscopy: Scattering phenomenon and application molecular vibrations. Introductory idea of Mass spectroscopy: Ionization, mass-to-charge ratio. Types of mass spectrometers and Applications in isotop analysis. GM counter: the principle, threshold voltage and application in nuclear physics.	**10**

III.	Optical Microscopy & Fluorescence Microscopy**:** Imaging principles and magnification techniques, Resolution, Rayleigh criterion. Techniques to enhance resolution (confocal microscopy). Electron Microscopy: SEM & TEM, Principles of electron-matter interaction, application in High-resolution imaging of nanostructures, thin films, and microstructures. Atomic Force Microscopy (AFM) & Scanning Tunneling Microscopy (STM).	**15**
IV.	Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC)**:** Measuring thermal stability and phase transitions**.** X-ray Diffraction (XRD) for Structural Analysis**.** Bragg's Law**,** crystallinity analysis, and size detection of nanoparticles. Magnetic property measurement trough VSM and SQID. Four-Point Probe Method & Hall Effect Measurements**.** I-V Characteristics Used to analyze diodes, transistors, and resistors. **C**-V Profiling (Capacitance-Voltage Measurement) – Determines doping profiles in semiconductors.	**15**
Total		**60**

Text:

1. **R.S. Khandpur** – *Handbook of Analytical Instruments* (McGraw Hill)
2. **Skoog, Holler & Crouch** – *Principles of Instrumental Analysis* (Cengage Learning)
3. **William F. Smith & J. Hashemi** – *Foundations of Materials Science and Engineering*

Reference Books:

4. **H.P. Klug & L.E. Alexander** – *X-ray Diffraction Procedures*
5. **C. Kittel** – *Introduction to Solid State Physics*
6. **J. Goldstein et al.** – *Scanning Electron Microscopy and X-ray Microanalysis*

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VIII

Course Level:

Name of the Subject: Research Methodology

Type of Course: Major

Subject Code: PHY012M802 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-3 **Total credits: 4**

Course Objectives:

This course provides a structured approach to research methodology**,** ensuring students develop skills in scientific investigation, data analysis, and academic writing.

. **Course Outcomes:**

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome (CO)**	**Blooms Taxonomy Level**
CO 1	**Understand** the basic principles of scientific research and its importance.	**BT 2**
CO 2	**Apply** various research techniques, including literature review data collection and analysis.	**BT 3**
CO 3	**Evaluate** different methodologies and select appropriate methods for different research projects.	**BT 4**
CO 4	**Analyze** and interpret research data for presentation, **Develop** scientific writing skills and understand the publication process.	**BT 5**

COURSE OUTLINE:

Modules	**Topics / Course content**	**Periods**
I.	Basic concepts of research and its role in scientific advancements. Definition and Characteristics of Research, Types of Research – Fundamental, Applied, Experimental, and Descriptive Research, Scientific Approach and Methodology – Steps in Research, Selecting the appropriate research methodology and experimental design: Qualitative vs Quantitative Research Methods, Theoretical and Experimental Research Design,Variables, Sampling Methods. Ethics in Research and Plagiarism.	**10**
II.	Literature Review & Research Problem Formulation: Finding, analyzing, and structuring information from previous research: Importance of Literature Review, Sources of Literature – Journals, Books, Theses, Patents, and Online Databases, Identifying Research Gaps and Formulating a Problem Statement, Citation & Referencing Styles (APA, IEEE, Chicago, etc.) and Bibliography.	**10**
III.	Data Collection, Analysis & Presentation: Collecting and analyzing data with appropriate statistical tools (Mean, Standard Deviation, Regression, Correlation), Primary & Secondary Data Collection, Error Analysis & Uncertainty in Measurements, Graphical Representation of Data – Histograms, Scatter Plots, Pie Charts, Introduction to Research Tools – MATLAB, SPSS, Origin, LaTeX.	**10**

IV.	Scientific Writing & Research Communication: Research Report Writing & Presentation Techniques, Scientific Paper Writing (Abstract, Introduction, Methodology, Results, Discussion, Conclusion), Publication Process – Journals, Peer Review, Impact Factor, Oral and Poster Presentations, Patents & Intellectual Property Rights (IPR).Indexing of paper and journal.	**10**
Total		**40**

Textbooks:

1. **C.R. Kothari & Gaurav Garg** – *Research Methodology: Methods & Techniques* (New Age)
2. **Wayne C. Booth et al.** – *The Craft of Research* (University of Chicago Press)
3. **Norman Blaikie** – *Designing Social Research*

Reference Books:

4. **J.W. Creswell** – *Research Design: Qualitative, Quantitative & Mixed Methods*
5. **Day & Gastel** – *How to Write & Publish a Scientific Paper*

Online Resources:

- **Google Scholar, IEEE Xplore, ScienceDirect** (For literature search)
- **LaTeX, Overleaf** (For report formatting)
- **SPSS, MATLAB, Python (Pandas, NumPy)** (For data analysis)

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
40 hrs	O	30 hrs

Level: Semester VIII

Course Level: C-803

Name of the Subject: Fiber Optics and Basics of Laser

Type of Course: Major

Subject Code: PHY012M803 **Scheme of Evaluation: Theory**

L-T-P-C: 4-0-0-4 **Total credits: 4**

Course Objective:

To develop a strong foundation for fiber optics and laser technology. To develop analytical concepts of fiber cable and laser properties and applications. To understand the relations and application and advantages. To apply knowledge of cables and lasers for communications.

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOM'S TAXONOMY LEVEL**
CO1	Remember the basic principle of optical fiber and its application in communication.	**BT1**
CO2	Understand the different types of fiber and evaluate the properties and calculate the advantages of different fibers	**BT2**
CO3	Apply laser technology to increase the quality factor of lasers in communications conclude for maximum transmission in optical fiber cable using laser technology	**BT3**
CO4	Analyze the different fibers and calculate how the fibers work in optical communications	**BT4**

COURSE OUTLINE:

Modules	**Topics & Course Contents**	**Periods**
I.	Optical fibers and their properties: Construction of optical fiber cable: Guiding mechanism in optical fiber and the Basic component of optical fiber communication, Principles of light propagation through a fiber: Total internal reflection, Acceptance angle (θ_a), Numerical aperture and Signal attenuation, Different types of fibres and their properties: Single and multimode fibers and Step index and graded index fibers	**15**
II	Fiber characteristics: Mechanical characteristics and Transmission characteristics, Absorption losses, scattering losses, Dispersion, Connectors and splicers, Fibre optic sensors, Optical communications; Point to point optical communication.	**15**
III	Properties of laser: Monochromaticity, Coherence, Divergence and Directionality and Brightness, Spontaneous and stimulated emission; Condition for lasing action, population inversion, Fundamental characteristics of lasers: Two-Level Laser, Three Level Laser, and four level lasers, Einstein's A and B co-efficient and their relation.	**15**
IV	Basic components of lasers: pumping sources, gain medium, laser resonator cavities: different types of laser cavity and their working principles, cavity stability and cavity modes, Q-factor, losses in the cavity; Types of lasers: solid state lasers (Ruby lasers) and Semiconductor diode lasers. Working principles and applications of lasers (Holography, pollution measurement)	**15**
	TOTAL	**60**

Textbook:

1. *An Introduction to Fiber Optics,* Ajoy Ghatak, K. Thyagarajan, Cambridge University Press,Online publication date: June 2012, Print publication year:1998, Online ISBN:9781139174770
2. *Laser and nonlinear optics*, B.B. Laud, New age international (P)limited, 3rd edition, 2011.

Reference Books:

1. R. P. Khare, *Fiber optics and optoelectronics*.Oxford University Press, 2004
2. Thyagarajan K, and Ghatak A., *Laser's fundamentals and applications*, Spinger, New York,ISSN-1868-4513, 2010.
3. Karl F. Renk, *Basics of Laser Physics* , Springer; 2nd ed. 2017 edition (April 7, 2017)

Level: Semester VIII

Course Level: C-804

Name of the Subject: Plasma and Space Physics

Type of Course: Major

Subject Code: PHY012M804 **Scheme of Evaluation: Theory**

L-T-P-C: 3-1-0-4 **Total credits: 4**

Course Objectives:

This course will help the students in understanding Lagrangian and Hamiltonian dynamics. It will also help the student to analyze the impact of different constraints of motion in a few physical systems.

Course Outcomes:

On successful completion of the course, the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remembe**r fourth state of matter, plasma, ionosphere etc.	**BT 1**
CO 2	**Understand** the Debye shielding, fluid equation of motion, Solar flares, Sunspots	**BT 2**
CO 3	**Apply** equation of continuity, equation of state to understand plasma, ionospheric density.	**BT 3**
CO 4	**Analyze** MHD waves: magneto-sonic and Alfven waves, Solar flares, Sunspots, plasma in the Earth's middle and inner magnetosphere	**BT 4**

COURSE OUTLINE:

Modules	**Course Contents**	**Periods**
I.	**Plasma Physics:** Understanding of elementary concepts: plasma oscillations, Debye shielding, plasma parameters, criteria for plasmas, analysis of Plasma confinement: single particle motion, $\nabla B \perp B$: Grad- B drift, curvature drift, their applications and analysis. $\nabla B \parallel B$: magnetic mirrors, non-uniform E Field, time-varying E Field, time-varying B Field, adiabatic invariants: first, second and third adiabatic invariant (Pinch effect, magnetic mirrors); Evaluation of related problems.	**15**
II	**Plasma as fluids:** Analysis of relation of plasma physics to ordinary electromagnetics: Maxwell's equations, dielectric constant of a plasma; fluid equation of motion, convective derivative, stress tensor, collisions, comparison with ordinary hydrodynamics, analysis of equation of continuity, equation of state; plasma approximation. Evaluation of related problems. MHD waves: magneto-sonic and Alfven waves, propagation at arbitrary directions: pure Alfven wave, fast and slow MHD waves, phase velocities, wave normal surfaces.	**15**
III.	**Space Physics:** Introduction: Understanding of early studies on geomagnetic field, ionosphere and magnetosphere, magnetospheric exploration, planetary and interplanetary exploration. Analysis of Solar phenomena: structure of the Sun, Solar activity, prominences, coronal heating, Solar flares, Sunspots. Analysis of solar wind properties, solar wind formations, interaction of Solar wind with magnetized and unmagnetized planets. Evaluation of related problems.	**15**
IV	Ionosphere: Concept of Ion production and loss, determination of ionospheric density. Magnetosphere: Analysis of magnetopause, magnetotail, magnetic reconnection, plasma flow in the magnetosphere, magnetic field configuration of the Earth's magnetosphere, plasma in the Earth's middle and inner magnetosphere, Ionosphere-Magnetosphere coupling, Evaluation of related problems.	**15**
	Total	**60**

Texts:

1. *Plasma Physics and Controlled Fusion*; Chen F.F., Springer International, 3rd Ed., 2016, Switzerland
2. *Fundamentals of Plasma Physics;* Bittencourt J.A. 3rd Ed., 2004, *Springer* (India)
3. *Introduction to Space Physics*; Russell C. T., Cambridge University Press ; 1st Ed., 1995, Cambridge

References:

1. Gurnett D. A. and Bhattacharjee A.; *Introduction to Plasma Physics with space and laboratory applications*, Cambridge University Press, 1st Ed., 2005, Cambridge.
2. Robert J. G. and Rutherford P. H.; *Introduction to Plasma Physics*, IOP Publishing Ltd, 1st Ed. (Reprint) 1995, Philadelphia

Credit Distribution		
Lecture/ Tutorial	Practical	Experiential Learning
60 hrs	O	30 hrs

Level: Semester VIII

Course Level:

Name of the Subject:

Nanophysics Type of

Course: Major

Subject Code: PHY012M805 **Scheme of**

Evaluation: Theory L-T-P-C: 4-0-0-4 **Total credits: 4**

This course introduces the basic concepts and principles to understand the physics of nanomaterials. The emphasis of this course is to impart the understanding of the effect of dimensional confinement of charge carries on the electrical, optical and structural properties.

Course Outcomes:

Upon successful completion of the course students will be able to:		
Sl. No.	**COURSE OUTCOME (CO)**	**BLOOMS TAXONOMY LEVEL**
CO1	Remember the difference between nanomaterials and bulk materials and their properties.	**BT1**
CO2	Understand the concept of various characterization tools required to study the structural, optical and electrical properties of nanomaterials and learn the applications areas of nanomaterials.	**BT2**
CO3	Apply the knowledge to resolve the related problems.	**BT3**
CO4	Analyze the concepts of the physics of nanomaterials, to solve problems, with logical interpretations and critical thinking.	**BT4**

COURSE OUTLINE:

Modules	Topics / Course content	Periods
I.	Introduction to nanoscale physics: Definition, Difference between bulk and nanoscale materials and their significance, Importance of Nanoscale and Technology, History of Nanotechnology, 0D, 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), density of states of materials at nanoscale.	**15**
II.	Synthesis of nanomaterials: Different approaches: Top-down approach and bottom-up approach. Top-down approach: photolithography, electron-beam lithography. bottom-up approach: chemical methods, sol-gel processing, hydrothermal process.	**15**
III.	Characterization of materials: Structure and Surface morphology: Phenomena of diffraction radiation, X-ray diffraction, phase identification, Scherrer formula, scanning electron microscopy (SEM), transmission electron microscopy (TEM), Spectroscopy: Working principle of UV-Vis spectroscopy, IR Spectroscopy, Raman and Photoluminescence Spectroscopy.	**15**
IV.	Properties of nanomaterials: Properties at the nanoscale, effect of confinement, quantum confinement, size quantization effect on electronic state, surface-to-volume ratio, chemical properties of nanomaterials. Nanotechnology in different fields.	**15**
Total		**60**

Texts:

1. *Nanostructures and Nanomaterials: Synthesis, Properties, and Applications*; G. Cao, Y. Wang, World Scientific, 2nd Ed.,2011, Singapore
2. *Introduction to Nanotechnology;* C. P. Poole, J. F. J. Owens, Wiley India ,1st Ed.,2003, New Delhi

Reference:

1. T. Pradeep; *A Textbook of Nanoscience and Nanotechnology*, Tata McGraw Hill, 1st Ed., 2012, New Delhi

NPTEL link: https://nptel.ac.in/courses/118102003