SCHEME OF EXAMINATION

&

DETAILED SYLLABUS

For

Choice Based Credit System

M.Sc. in Physics

(w.e.f. 2021 – 2022)

Department of Physics

Kalinga University, Naya Raipur, Chhattisgarh

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1.	Postgraduates will pursue higher studies in related fields including management and carry out research.
PEO2.	Postgraduates will perform as employers in private/government institutions rising up to top positions.
PEO3	Postgraduates will become entrepreneurs.

PROGRAM OUTCOMES (POs)

PO1	**Critical Thinking:** Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.
PO2	**Effective Communication:** Speak, read, write and listen clearly in person and through electronic media and make meaning of the world by connecting people, ideas, books, media and technology.
PO3	Social Interaction: Elicit views of others, mediate disagreements and help reach conclusions in group settings.
PO4	**Effective Citizenship:** Demonstrate empathetic social concern and equity-centered national development, and the ability to act with an informed awareness of issues and participate in civic life through volunteering.
PO5	**Ethics:** Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them.
PO6	**Environment and Sustainability:** Understand the issues of environmental contexts and sustainable development.
PO7	**Self-directed and Life-long Learning:** Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1.	Postgraduates will develop the critical analysis and problem-solving skills required in the application of principles of Physics.
PSO2	Escalating sufficient academic and realistic background/understanding of physics as per UGC framework
PSO3	Understanding fundamental concepts of classical and statistical mechanics to put in plain words the explanation of physical events with appreciable limitations

PSO4	Refreshing the concepts of electrodynamics, condensed matter physics, Nuclear & particle physics, atomic & molecular physics for better understanding of advanced physical concepts
PSO5	Understanding in detail the basic and advanced concepts of quantum mechanics because the nature is governed by regulations of quantum mechanics
PSO6	The essential features of electronic devices and related techniques to have a perceptive of many household electronic devices and Performing handful of experiments/projects as per program framework
POS7	Understanding advanced and special/elective subjects like plasma physics, lasers, advanced electronics and their applications for welfare of mankind
PSO8	Postgraduates will be prepared with a working knowledge of experimental/computational techniques and instrumentation required to work independently in research or industrial environments.
PSO9	Postgraduates will have strong capability in organizing and presenting the acquired knowledge coherently both in oral and written discourse.
PSO10	Postgraduates will successfully compete for current employment opportunities.

M. Sc. – PHYSICS

M. Sc. in Physics is a full time 2-year (4-semesters course). There will be five theory papers and two laboratory courses in 1st to 3rd semester and 4th Semester consist of major project. In each semester, there will be two internal examinations/assessments. Semester wise course structure along with distribution of marks is as follows:

Semester – I

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY101	Mathematical Physics	4	-	70	30	100
MPHY102	Classical Mechanics	4	-	70	30	100
MPHY103	Electrodynamics	4	-	70	30	100
MPHY104	Electronics – I	4	-	70	30	100
GE-1	**Choose Any One MPHY105A/ MPHY105B**	4	-	70	30	100
MPHY105A	Research Methodology					
MPHY105B	Science Journalism					
MPHY106P	General & Optics Laboratory	-	2	30	20	50
MPHY107P	Electronics Laboratory – I	-	2	30	20	50
	Total	24		**410**	**190**	**600**

Semester – II

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY201	Quantum Mechanics – I	4	-	70	30	100
MPHY202	Statistical Mechanics	4	-	70	30	100
MPHY203	Computational Methods & Programming	4	-	70	30	100
MPHY204	Electronics – II	4	-	70	30	100
GE-2	**Choose Any One MPHY205A/ MPHY205B**	4	-	70	30	100
MPHY205A	Entrepreneurship					
MPHY205B	Intellectual Property Rights					
MPHY206P	Fortran and Numerical Analysis Laboratory	-	2	30	20	50
MPHY207P	Electronics Laboratory – II	-	2	30	20	50
	Total	24		**410**	**190**	**600**

Semester – III

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY301	Quantum Mechanics – II	4	-	70	30	100
MPHY302	Plasma Physics	4	-	70	30	100
MPHY303	Atomic & Molecular Physics	4	-	70	30	100
(DSE-1)	**Choose Any One MPHY 304A/ MPHY 304B**	4	-	70	30	100
MPHY304A	Solid State Physics					
MPHY304B	Experimental Physics					
(DSE-2)	**Choose Any One MPHY 305A/ MPHY 305B**	4	-	70	30	100
MPHY305A	Astronomy & Astrophysics					
MPHY305B	Nanotechnology: Principles & Practices					
MPHY304A(P)	Solid State Physics Laboratory	-	2	30	20	50
MPHY304B(P)	Experimental Physics Laboratory					
MPHY306P	Minor Project	-	2	100	50	150
	Total	24		**480**	**220**	**700**

Semester – IV

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY401 P	Major Project / Dissertation	-	24	450	150	600
Total						**600**

***Project Dissertation 200**
***Presentation 100**
***Viva Voce 100**
***Scientific Paper 50**

Semester – I

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY101	Mathematical Physics	4	-	70	30	100

Objectives

To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.

Learning Outcomes

1. The students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of physics.
2. Will enable students to apply integral transform to solve mathematical problems of interest in physics.
3. The students will be able to use Fourier transforms as an aid for analyzing experimental data.
4. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

Unit -I **12 Hrs**

Vector space and Matrices, Linear independence, Bases, dimensionality, Inner product, Linear transformation, matrices, Inverse, Orthogonal and Unitary matrices, independent element of a matrix, Eigen values and eigen Vectors, Diagonalization, Complete orthonormal sets of functions.

Unit–II **12 Hrs**

Complex Variables: Cauchy- Riemann condition, analytic functions, Cauchy's theorem, Cauchy integral formula, Laurent series, singularities, residue theorem, contour integration, evaluation of definite integrals, problems, Cauchy's Residue theorem.

Unit–III **12 Hrs**

Differential equations, first order differential equation, second order differential equation with constant coefficients, second order linear ODEs with variable coefficients, Solution by series expansion, non-homogenous differential equations and solution by the method of Green's functions.

Unit–IV **12 Hrs**

Special functions, Legendre, Bessel, Hermite and Laguerre functions with their physical applications, generating functions, orthogonality conditions, recursion relations.

Unit-V **12 Hrs**

Integral transforms, Fourier integral and transforms, inversion theorem, Fourier transform of derivatives, convolution theorem.
Laplace Transform (LT), LT of Derivatives, Inverse LT, Fourier series; properties and applications, discrete Fourier transform.

TEXT AND REFERENCE BOOKS

1. Mathematical Methods for Physics, by G. Arfken.
2. Matrices and Tensors for Physicist, by A. W. Joshi.
3. Advanced Engineering Mathematics, by E. Kroyazig.
4. Special Functions, by E. B. Rainville.
5. Special Functions, by W.W. Bell.
6. Mathematical Method for Physicist and Engineers, by K. F. Relly, M. P. Hobson and S. J. Bence
7. Mathematics for Physicists, By Marry L. Boas.

Course Outcomes (COs):

CO1	To develop knowledge in mathematical physics and its applications.
CO2	To develop expertise in mathematical techniques those are required in physics.
CO3	To enhance problem solving skills.
CO4	To give the ability to formulate, interpret and draw inferences from mathematical solutions.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY102	Classical Mechanics	4	-	70	30	100

Objectives

The course aims to develop an understanding of Lagrangian and Hamiltonian formulationwhich allow for simplified treatments of many complex problems in classical mechanics andprovides the foundation for the modern understanding of dynamics.

Learning Outcomes

1. The students will be able to apply the Variational principles to real physical problems.
2. The students will be able to model mechanical systems, both in inertial and rotating frames, using Lagrange and Hamilton equations.

Unit–I **12 Hrs**

Preliminaries, Newtonian mechanics of one and many particle systems, Conservation laws, Constraints & their classification, Principle of virtual work, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and dissipation function, Gauge Function, Simple applications of the Lagrangian formulation, Hamilton's principle, Lagrange's equations from Hamilton's principle, Conservation theorems and Symmetry properties, Energy function and the conservation of energy.

Unit-II **12 Hrs**

The Hamiltonian formulation of mechanics, Legendre transformations and the Hamilton's equations of motion, Cyclic coordinates and Conservation Theorems, Hamilton's equations from Hamilton's principle, The principle of least action. Simple applications of the Hamiltonian formulation.

Unit- III **12 Hrs**

Canonical transformations with examples, the harmonic oscillator, Poisson's brackets, Equations of motion and conservation theorems in the Poisson Bracket formulation. Hamilton-Jacobi (HJ) theory: The HJ equation for Hamilton's principal function, Harmonic oscillator as an example of the HJ method, The HJ equation for Hamilton's characteristic function, the action-angle variables

Unit –IV **12 Hrs**

The Central force: Two-body central force problem and its reduction to the equivalent one-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The differential equation of the orbit, Closure and stability of orbits, The Kepler problem, Scattering in a central force field: Rutherford scattering.

Unit – V **12 Hrs**

Rigid body dynamics, The Euler angles, Euler's theorem on the motion of a rigid body, Rate of change of a vector, The Coriolis force, Angular momentum and Kinetic energy of motion about a point, The Euler equations of motion of rigid bodies. Formulation of the problem of small oscillations, the eigen-value equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, free vibration of linear triatomic molecule.

TEXT AND REFERENCE BOOKS

1. Classical Mechanics, By N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)
2. Classical Mechanics, by H.Goldstein (Addison Wesley, 1980)
3. Classical Mechanics, by H.Goldstein, C Poole & J Fafko (Pearson Education, Inc, 2002)
4. Mechanics, by A.Sommerfeld, (Academic press, 1952)
5. Introduction to Dynamics by Perceival and D.Richaeds (Cambridge University, press, 1982).

Course Outcomes (COs):

CO1 To give students a solid foundation in classical mechanics.
CO2 To introduce general methods of studying the dynamics of particle systems.
CO3 To give experience in using mathematical techniques for solving practical problems.
CO4 To lay the foundations for further studies in physics and engineering.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY103	Electrodynamics	4	-	70	30	100

Objectives

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.

Learning Outcomes

1. To explain and solve advanced problems based on classical electrodynamics using Maxwell's equation.
2. The students will be able to analyze s radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.
3. The students will have an understanding of the covariant formulation of electrodynamics and the concept of retarded time for charges undergoing acceleration.

Unit- I **12 Hrs**

Electrostatics: Coulombs law, Electric field and potential, Work and energy in electrostatics, Polarization, Bound charge and physical interpretation of Bound charge.

Magnetostatics: Biot-savart law, divergence of curl of B, Magnetization, Bound current and physical interpretation of Bound current, Ohms law, Faradays law and Maxwell's equation, Conservation law.

Unit – II **12 Hrs**

Scaler and Vector potential, Gauge transformations, Coulomb Gauge and Lorentz Gauge, Retarded potential, Jefimenko's equation, Lienard-Wiechert potential and fields for a point charge.

Unit –III **12 Hrs**

Radiation, dipole radiation, point charge, total power radiated by an accelerated charge-Larmor's formula and its relativistic generalization, angular distribution of radiation emitted by an accelerated charge, radiation emitted by a charge in arbitrary extremely relativistic motion, distribution in frequency and angle of energy radiated by accelerated charge.

Unit –IV **12 Hrs**

Bremsstrahlung: emission from single-speed electrons, thermal Bremsstrahlung emission and absorption, Synchrotron radiation: spectrum of synchrotron radiation, spectral index for power law electron distribution, transition from Cyclotron to Synchrotron emission, Cherenkov radiation.

Unit – V **12 Hrs**

Electrodynamics and Relativity: The Special Theory of Relativity, Einstein's Postulates, The Geometry of Relativity, The Lorentz Transformations, The Structure of Space-time, Relativistic Mechanics, Proper Time and Proper Velocity, Relativistic Energy and Momentum, Relativistic Kinematics, Relativistic Dynamics, Relativistic Electrodynamics, Magnetism as a Relativistic Phenomenon, How the Fields Transform, The Field Tensor, Electrodynamics in Tensor Notation, Relativistic Potentials, Special theory of relativity, Einstein postulates, Lorentz transformation, the Structure of space time, Relativistic mechanics and electrodynamics in tensor notation.

TEXT AND REFERENCE BOOKS

1. Jackson, classical electrodynamics.
2. Panofsky and Phillips: Classical electricity and magnetism.
3. Intro. to Electrodynamics: David J. Griffiths

Course Outcomes (COs):

CO1 Reviewing basics of electrostatics and magnetostatics to comprehend Maxwell's equations and their solution in various media.
CO2 Understanding radiations and related physics by moving charges, the concepts of retarded potentials and Abrahm-Lorentz method of self-force.
CO3 Describing 4-vectors and Lorentz transformation in 4-dimensional space to revise invariance of charge & potential under Lorentz transformation and furthermore the motion of charged particles in electromagnetic fields.
CO4 Solving questions based on tutorial problems casing above topics/concepts.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY104	Electronics – I	4	-	70	30	100

Objectives

To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies that surround us.

Learning Outcome

The students will be able to use techniques for analyzing analogue and digital electronic circuits; and formulate the concepts of operational amplifier and Field Effect Transistors (FET); identify its major properties and main types of FET and op-amps circuits.

Unit – I **12 Hrs**

Special Bipolar devices: Thyristors- the four-layer diodes and their basic characteristics, Shockley diode, three terminal thyristor, Diac&Triac, SCR, UJT, Field controlled Thyristors.

Unit – II **12 Hrs**

Unipolar Devices: JFET, MESFET and MOSFET, basic structure, working and device I-V characteristics, small signal equivalent circuit for Microwave performance, Introduction to MIS and MOS diodes, charge coupled devices (CCDs), basic structure and working principle, MOSFET-basic device characteristics, types of MOSFET.

Unit- III **12 Hrs**

Special Microwave Devices: Tunnel diode and backward diode- basic device characteristics, IMPATT diodes and their static and dynamic characteristics, Transfer electron devices-transferred electron effect, PIN diodes, Gunn diodes.

Unit – IV **12 Hrs**

Photonic Devices: Radiative transitions, LEDs, Visible and infrared SC lasers; Photo detectors; Photo conductor, & Photodiode, Solar cells, Solar radiation and ideal conversion efficiency, p-n junction solar cells, Hetero junction. Interface thin film solar cells.

Unit – V **12 Hrs**

Optical Modulators and Display Devices: Modulation of light- Birefringence, Optical activity, Electro-optic, Magneto-optic and Acoustic- optic effects, Materials exhibiting these properties, Non-linear optics.

Display devices: Luminescence, Photo-luminescence, Electro-luminescence, Liquid crystal displays, Numeric displays.

TEXT & REFERENCE BOOKS:

1. Semiconductor Devices – Physics and Technology, by S M Sze, Wiley (1985).
2. Introduction to semiconductor device, M.S. Tyasi, John Wiley and sons.
3. Measurement, Instrumentation and experimental design in physics and engineering by M. Sayer and A. Mansingh, Prentice Hall India 2000.
4. Optical electronics by Ajay Ghatak and K. Thyagarajah, Cam. Univ. Press.
5. Opto electronics – An introduction: J.Wilson and JFB Hawkes (Eastern Economy Edition).
6. Optical Communications: J.H. Franz and V.K. Jain (Narosa).

Course Outcomes (COs):

CO1 To become skilled at the basic concepts of JFET, BJT, MOSFET, MESFET and microwave devices.

CO2 To study and understand the various photonic devices including diode lasers and their applications.

CO3 To be acquainted with the concepts and applications of digital integrated circuits and operational amplifiers.

CO4 Describing memory devices and the devices based on electro/magneto/acousto-optic, piezoelectric, and surface acoustic effects.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
PHY105A (Elective)	Research Methodology	4	-	70	30	100

Objectives:

1. Understand some basic concepts of research and its methodologies
2. Identify appropriate research topics
3. Select and define appropriate research problem and parameters
4. Prepare a project proposal (to undertake a project)
5. Organize and conduct research (advanced project) in a more appropriate manner

Unit I

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process

Unit II

Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance , Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

Unit III

Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

Unit IV

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in

Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

Unit V

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

Learning Outcomes:

1. Students will understand a general definition of research design.
2. Students will know why educational research is undertaken, and the audiences that profit from research studies.
3. Students will be able to identify the overall process of designing a research study from its inception to its report.
4. Students will be familiar with ethical issues in educational research, including those issues that arise in using quantitative and qualitative research

Assessment Tools:

Written examinations, Case study discussions, Viva examinations.

Books Recommended:-

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
PHY105B (Elective)	**Science Journalism**	4	-	70	30	100

Objectives

- Students will learn the mechanics of science writing, including research, sourcing, and generating story ideas; interviewing, note-taking, and organization; fact-checking, editing, writing for story, structure, and formatting.
- Students will practice writing for multiple public, academic, and professional audiences and contexts using writing strategies, conventions, genres, technologies, and formats to communicate effectively.

UNIT 1 Science communication at the end of the Enlightenment and the importance of notions of the public in the origin of modern science - development of new audiences for science in the Nineteenth century and the emergence of new science communication media (e.g. mechanics' institutes, science journalism, public museums and zoos) - advent of the figure of the scientist as public expert and the debate about 'Two Cultures' – difference between science journalism and science communication

UNIT 2 Introduction of Western science in India through missionaries, travelers, army and civilian army of the East India Company– science in the 18th and 19th century –emergence of Indian pioneer scientists – science teaching-– developments during post-Independence period – emerging areas of science and technology – convergence in study of science

UNIT 3 Institutions of science in India - the role of the Asiatic Society – Bose Institute – Indian Institute of Science - Council of Scientific and Industrial Research (CSIR) – Indian Space Research Organization (ISRO) – Indian Science Congress organizations for popularization of science – NCSTC and Vigyan Prasar – noted science societies at state level – Science and Technology Academies – awards for science communication and popularization.

UNIT 4 The boom in new media during the twentieth century and their impact on science journalism - role of a science page editor – popular science magazines in the west – science magazines in India – the ideal science reporter - scope of science journalism on radio & television in developing countries – science serials on radio and television – Bharat ki Chaap on Doordarshan – Science serials on All India Radio - tech news - understanding present market trends.

UNIT 5 Science as an essential element in political, corporate and community news – major issues in science journalism – environmental pollution – genetically modified crops – research for disease prevention and eradication – nuclear power – disaster mitigation – scientific knowledge for effective governance – the North-South divide in science research and scientific development.

Learning Outcomes

- They will appreciate the digital landscape within which science journalism exists today by learning: blogging in science journalism (honing your craft, developing a voice); how to get work (pitching and staying relevant); the value of social networks for science journalism (sharing stories, finding stories, joining discussions and finding sources); digital strategies employed by major news organizations (data visualization, multimedia, community building).
- Students will analyze and learn about the structure of several types of data including numbers, texts and documents. Students will learn the skills to examine, evaluate, and critique those data, extract patterns, summarize features, create visualizations, and provide insights, while learning to be sensitive to ethical concerns associated

Assessment Tools: Written examinations, Case study discussions, Viva examinations.

Reference Book:

1. Mass Communication: A Critical analysis, Keval J Kumar
2. Professional Journalism, M V Kamat
3. Theory and Practice of Journalism, B N Ahuja
4. Professional Journalist, John Hohenberg
5. Understanding Media, Marshall McLuhan 6. Journalism in India,Nadig Krishnamurthy, Mysore University Press
6. Barbara Gastel, Presenting Science to the Public.
7. Blum, Deborah, Knudson, Mary & Marantz Henig, Robin. A Field Guide for Science Writers: The Official Guide of the National Association of Science Writers. (2005)
8. D. Perlman, Science and the Mass Media.
9. Elise Hancock, Ideas into Words: Mastering the Craft of Science Writing. Baltimore and London: Johns Hopkins, 2003.
10. N Corcoran (Ed.). Communicating health: strategies for health promotion. Sage. (2013).
11. O.P. Jaggi, A Concise History of Science including Science in India.
12. R. Sundara, Popular Science in Mass Media.
13. Renata Schiavo, Health Communication: From Theory to Practice. John Wiley & Sons. 2013
14. Sharon, M. Friedman, Sharon, Woody, Carlol, L. Rogers (Ed) : Scientists and Journalists, Reporting Science as News.
15. Warren Burkett, News Reporting : Science Medicine and High Technology

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY106P	General and Optics Laboratory	-	2	30	20	50

General and Optics Laboratory (MPHY105P)

Course Objective

To make the student familiar with both historically important optical experiments and modern optical instruments and methods. The student will also have the opportunity to learn how to use and calibrate optical measuring equipment and identify sources of error and uncertainty in practical work. In addition, the student will learn to present experimental results in the form of a scientific report, both written and oral.

Learning Outcomes

On completion of the course the student should have the following learning outcomes defined in terms of knowledge, skills and general competence:

The student can –

1. Understand the physics principles behind the experiments.
2. Identify errors in the experiments.
3. Understand the functions of components used in the experiments.

List of Experiments

1. Determination of wavelength of mercury light by constant deviation spectrometer using Hartmann formula.
2. Ultrasonic velocity in a liquid as a function of temperature using ultrasonic interferometer.
3. Experiment on transmission line (A) Determination of characteristics impedance, (B) Study of voltage distribution.
4. Determination of the Curie temperature of ferromagnetic material.

5. Determination of forbidden gap of a diode by plotting reverse saturation current as a function of temperature.

6. Determination of short half-life of a given source which can be obtained from a mini generator or produced with a neutron source by activation.

7. X-ray diffraction by Telexometer.

8. Determination of ionization potential of Lithium/Mercury.

9. Determination of e/m of electron by Normal Zeeman Effect using Febry -Perot Etalon.

10. Determination of Dissociation energy of iodine (I_2) Molecule by photography, the absorption bands of I_2 in the visible region.

11. Measurement of wavelength of He-Ne Laser light using a ruler and thickness of thin wire by the laser.

12. To study Faraday Effect using He-Ne Laser.

Course Outcomes (COs):

CO1	To make the student familiarize with the basics of experimental physics.
CO2	To enable the students to explore the concepts involved in the thermodynamic processes.
CO3	To make the students understand the basics of modern optics.
CO4	To make the students verify experimentally the basic laws of physics.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY107P	Electronics Laboratory – I	-	2	30	20	50

Electronics Laboratory – I (MPHY106P)

Course Objectives:

1. To study basic electronic components.
2. To observe characteristics of electronic devices.

Learning Outcomes:

1. At the end of the course the students can able to
2. Measure voltage, frequency and phase ofany waveform using CRO.
3. Generate sine, square and triangular waveforms with required frequency andamplitude using function generator.
4. Analyze thecharacteristics of different electronic devices such as diodes, transistors etc., and simple circuits like rectifiers, amplifiersetc.

List of Experiments

1. Design & Study of Regulated Power supply.
2. Study of Transistor Amplifiers in CE, CB, and CC modes.
3. Study of Transistor Bias Stability.
4. Study of Astable, Monostable and Bistable Multivibrator.
5. Study of Silicon Controlled Rectifier.
6. Experiment of Uni – Junction Transistor and its application.
7. Experiment of FET and MOSFET characterization and application as an amplifier.
8. Study of Differential Amplifier.

9. Basic Logic gates and verification of their Truth- Tables.
10. Combinational logic gates and verification of De-Morgan's Theorem.
11. Study of Basic Operational Amplifier (741).
12. Study of Opto- Electronics Devices.

Course Outcomes (COs):

CO1 Solving tutorial problems based on above topics.
CO2 Performing laboratory experiments/project on above topics/concepts to realize the physics behind them.

Semester – II

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY201	Quantum Mechanics – I	4	-	70	30	100

Objectives

To provide an understanding of the formalism and language of non-relativistic quantum mechanics.To understand the concepts of time-independent perturbation theory and their applications to physical situations.

Learning Outcomes

1. The students will be able to formulate and solve problems in quantum mechanics using Dirac representation.
2. The students will be able t0 grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.
3. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.

Unit – I **12 Hrs**

Inadequacy of classical mechanics, Plank quantum hypothesis and radiation law, Photoelectric effect, de-Broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, stationary states, one-dimensional problems; walls and barriers, Schrödinger equation for harmonic oscillator and its solution, uncertainty relations, states with minimum uncertainty product.

Unit–II **12 Hrs**

Superposition principle, general formalism of wave mechanics, representation of states and dynamical variables, commutation relationship, completeness and normalization of eigen functions, Dirac-delta function, Bra &Ket notation, matrix representation of an operator, harmonic oscillator and its solution by matrix method, Heisenberg equation of motion.

Unit -III **12 Hrs**

Angular momentum in quantum mechanics, commutation relationships, eigen values, spin angular momentum, Pauli`s matrices, addition of angular momentum, Clebsch-Gordon coefficients, Combining spin ½ and orbital angular momentum *l*.

Unit – IV **12 Hrs**

Central force problem, spherically symmetric potentials in three dimensions, separation of wave equation, parity, three-dimensional square-well potential and energy levels, the hydrogen atom; solution of the radial equation, energy levels and stationery state wave functions, discussion of bound states, degeneracy.

Unit –V **12 Hrs**

Time– independent perturbation theory, non-degenerate case, first order and second perturbations with the example of an oscillator, degenerate cases, removal of degeneracy in second order, Zeeman effect without electron spin, first-order Stark effect in hydrogen, perturbed energy levels, correct eigen function, occurrence of permanent electric dipole moments.

TEXT AND REFERENCE BOOKS:

1. L.I. Schiff: quantum mechanics (McGraw-Hill).
2. S. Gasiorowicz, Quantum Physics (Wiley).
3. Landau and Lifshitz: Non-relativistic quantum mechanics.
4. B. Craseman and Z. D. Powell: quantum mechanics (Addison Wesley)
5. A.P. Messiah: Quantum Mechanics.
6. J.J. Sakurai: Modern Quantum Mechanics.
7. Mathews and Venkatesan: Quantum Mechanics.

Course Outcomes (COs)

CO1 Answering why and how quantum mechanics with understanding of basic postulates and solution of Schrodinger equation for one dimensional problem.

CO2 Having basic knowledge of linear vector space, Bra and Ket algebra, matrix theory and uncertainty relations.

CO3 Solving Schrodinger wave equation for three dimensional problems like H-atom, harmonic oscillator, square well potential and their application to atomic spectra, molecular spectra and deuteron.

CO4 Understanding angular momentum in quantum mechanics, its matrix representation and coupling, Pauli spin matrices and the concept of Clebsch-Gorden coefficients.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY202	Statistical Mechanics	4	-	70	30	100

Objectives

To have an appreciation for the modern aspects of equilibrium and non-equilibrium statistical physics.To describe the features and examples of Maxwell-Boltzmann, Bose-Einstein and Fermi Dirac statistics

Learning Outcome

The students will be able to work out equations of state and thermodynamic potentials for elementary systems of particles; and use and develop mean field theory for first and second order phase transitions.

Unit –I **12 Hrs**

Foundation of statistical mechanics: macroscopic and microscopic states, contact between statistics and thermodynamics, physical significance of Ώ (N, V, E), the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Liouville`s theorem and its consequences, quantum states and phase space.

Unit – II **12 Hrs**

Elements of ensemble theory – A system in microcanonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density fluctuations and mutual correspondence of various ensembles.

Unit - III **12 Hrs**

Formulation of quantum statistics – Quantum mechanical ensemble theory, density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles.

Theory of simple gases –Ideal gas in various quantum mechanical ensemble, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions, statistics of occupation number. Monatomic and diatomic gases composed of particles with internal motion.

Unit - IV **12 Hrs**

Ideal Bose and Fermi gases -Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, thermodynamic behavior of an ideal Fermi gas, the electron gas, nonrelativistic and relativistic degenerate electron gas, theory of white dwarf stars.

Unit – V **12 Hrs**

Statistical Mechanics of interacting systems – the method of cluster expansion for a classical gas, Virial expansion of the equation of state.

Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, Brownian motion, Einstein and Langevin theory of Brownian motion.

TEXT & REFERENCE BOOKS:

1. R. K. Pathria, Statistical Mechanics (Pergamon Press).
2. L. D. Landau & E. M. Lifshitz (Butter worth and Heinemann Press).
3. FederickReif, Fundamental of statistical and thermal physics (McGraw-Hill publishers).
4. Kerson Huang, Statistical Mechanics (Wiley Eastern).

Course Outcomes (COs)

CO1	Understanding foundations of statistical mechanics and its association with thermodynamics to solve countless physical problems.
CO2	Describing Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics.
CO3	Explaining cluster expansion of a classical gas, dynamical model of phase transition and Landau theory of phase transition.
CO4	Elucidating thermodynamical fluctuations and Brownian motion on the basis of Langerin’s theory and Fokker-Planck equation.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY203	Computational Methods & Programming	4	-	70	30	100

Objectives

This hands-on course provides an introduction to computational methods in solving problems in physics. It teaches programming tactics, numerical methods and their implementation, together with methods of linear algebra. These computational methods are applied to problems in physics, including the modelling of classical physical systems to quantum systems, as well as to data analysis such as linear and nonlinear fits to data sets. Applications of high-performance computing are included where possible, such as an introduction to parallel computing and also to visualization techniques.

Learning Outcomes

On completion of this course, students should be able to:

1. Identify modern programming methods and describe the extent and limitations of computational methods in physics,
2. Identify and describe the characteristics of various numerical methods.
3. Independently program computers using leading-edge tools,
4. Formulate and computationally solve a selection of problems in physics,
5. Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.

Unit –I **12 Hrs**

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion.

Unit –II **12 Hrs**

Finite differences, interpolation with equally spaced and unevenly spaced points, curve fitting, polynomial least squares and cubic spline fitting. Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method.

Unit –III **12 Hrs**

Numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, predictor-corrector method, elementary ideas of solutions of partial differential equations.

Unit- IV **12 Hrs**

Elementary information about digital computer principles, compilers, interpreters and operating systems (Windows/Linux) Fortran programming, flow charts, integers and floating-point arithmetic, expressions, built in functions. Basic introduction of python programming, Basic mathematical operations using python programming.

Unit-V **12 Hrs**

Executable and non-executable statements, assignments, control and input-output statements, subroutines and functions; The statement functions, main features of functions and subroutines, subprogram, function subprogram, overall structure of FORTRAN program, external statement, subroutine subprogram, common statement, equivalence statement, operations with files-open and close statement, Format statements, field specifications.

TEXT AND REFERENCE BOOKS

1. Sastry: Introductory Methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis.
3. Antia: Numerical methods.
4. Raja Raman: FORTRAN programming.

Course Outcomes (COs):

CO1 Learning the essential components of programming in BASIC.
CO2 Understanding the computational skills of solving linear and non-linear algebraic/transcendental equations including simultaneous linear equations.
CO3 Being comfortable with the techniques of obtaining Eigen values & Eigen vectors of matrices, curve-fitting and numerical differentiation & integration.
CO4 Realizing the basic concepts of random variables, numerical solution of ordinary and partial differential equations.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY204	Electronics – II	4	-	70	30	100

Objectives

To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies that surround us.

Learning Outcome

1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
2. To prepare students to perform the analysis and design of various digital electronic circuits.

Unit-I **12 Hrs**

Number system and its conversion, Combinational Logic –Basic logic gates: OR, AND and NOT gates, NOR and NAND gates, Boolean algebra, De-Morgan's theorems, exclusive OR gate, characteristics of logic families, saturated logic families: RTL, DCTL, non-saturated logic families: TTL and ECL, Unipolar logic families.

Unit –II **12 Hrs**

Sequential Logic, Flip-flops: RS Flip-flop, level clocking, Edge triggered Flip Flops, D Flip flops. JK Flip-flops, J.K.master slave Flip-flops, Registers: buffer, shift and control shift registers, counters: ripple synchronous & ring counters, tri-state registers, Buffer: controlled buffer Register, Bus organized structure, Latch, multiplexer, Demultiplexer, decoder, ALU Memories: RAM, ROM, PROM, EPROM, A/D and D/A converters.

Unit- III **12 Hrs**

Operational Amplifier- Basic Op Amp. Differential amplifier, the emitter coupled Difference Amp, Transfer characteristics of a Diff. Amp., an example of an IC Op Amp., off set error voltage and currents, measurement of Op Amp. Parameters, frequency response of Op-amp. Linear analog systems: Basic Op Amp. Applications, Analog integration and differentiation, electronic analog computation, Non-linear analog systems: Comparators. Waveform generators.

Unit-IV **12 Hrs**

Microprocessors – Building concept of microprocessors, developing inside of microprocessor, Instruction codes, Instruction Register, Introducing RESET Pin, Introducing on chip oscillator, Interfacing I/O devices, Introducing Interrupt lines :Stack, Push, Pop operation, delay in servicing interrupts, multiply interrupts, location for interrupts .Introducing slow and fast data transfer, Status of microprocessor, interrupt pins, General purpose Register, flag Register, Increment/decrement register. Features of 8085 microprocessor. Pin diagram of 8085, block diagram of 8085. CPU of a microprocessor, timing and control, system timings and interrupt timings of 8085, registers in 8085, interfacing memory and I/O devices- a preliminary ideas. Number system, Floating Point notation.

Unit – V **12 Hrs**

Instructions set of 8085, types of instructions- Data transfer group, Arithmetic logic, branch group, stack I/O machine control group, addressing mode of Intel 8085, examples of Assembly language programs of 8085, summing of two 8-bit numbers to result a 16-bit number, summing two 16-bit number, multiplying two 8-bit number to result a 16-bit product, block transfer of data from one memory block to other, BCD to hexadecimal data, finding the largest number in a series.

TEXT AND REFERENCE BOOKS:

1. Integrated Electronics: J.MillmanR.C.C.Halkias.
2. Operational amplifier linear integrated circuits, by Romakanth A. Gayakwad PHI, second edition 1991.
3. Digital computer electronics- An introduction to microcomputers-A. P. Malvino.
4. Microprocessor architecture, programming applications with 8085/8086 by Ramesh S. Gaonkar, Willey-Eastern limited 1987.
5. Introduction to microprocessors – A. P. Mathur (Tata McGraw).
6. Microprocessor’s fundamentals- SchanmiOutling Service Author Pocer L. Tokheim.
7. Integrated circuits: K KBotkar(Khanna publications)
8. Digital Electronics: R P Jain (Tata McGraw Hill)
9. Microprocessors: B Ram

Course Outcomes (COs):

- CO1 To understand the basic elements of communication electronics, microwave transmission and satellite communication.
- CO2 To appreciate the construction, operation and application of microwave devices and radar.
- CO3 Learning the operation of Intel 8085 microprocessor its interrupts.
- CO4 Analyzing potential aspects of programmable interface devices and interfacing with D/A & A/D converters.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
PHY205A (Elective)	Entrepreneurship	4	-	70	30	100

Course Objective

The goals of this programme are to inspire students and help them imbibe an entrepreneurial mind-set. The students will learn what entrepreneurship is and how it has impacted the world and their country. They will be introduced to key traits and the DNA of an entrepreneur, and be given an opportunity to assess their own strengths and identify gaps that need to be addressed to become a successful entrepreneur. The programme comprises several short courses, each focusing on a specific entrepreneurial knowledge or skill requirement such as creative thinking, communication, risk taking, and resilience and helping them become career ready, whether it is entrepreneurship or any other career.

Unit I **Contact Hours: 12**

Entrepreneurship: Concept of Entrepreneur, Entrepreneurship and Manager, Difference between Entrepreneur and Entrepreneur, Entrepreneurship, Attributes and Characteristics of successful entrepreneurs. Functions of an Entrepreneurs Function of an Entrepreneur, Classification of Entrepreneurs, Role of Entrepreneur in Indian Economy, Developing Entrepreneurial culture, Factors influencing Entrepreneurship Growth – Economic, Non-Economic Factors, For profit or Not for profit entrepreneurs, Constraints for the Growth of Entrepreneurial Culture, Entrepreneurship as a career, Entrepreneurship as a style of management, Emerging Models of Corporate Entrepreneurship, India's start up revolution-Trends, Imperatives, benefits: the players involved in the ecosystem, Business Incubators-Rural Entrepreneurship, social entrepreneurship, women entrepreneurs, Cases of Tata, Birlas, Kirloskar and new generation entrepreneurs in India.Case study on related topics.

Unit II **Contact Hours: 12**

Theories of entrepreneurship: Innovation Theory by Schumpeter & Imitating, Theory of High Achievement by McClelland, X-Efficiency Theory by Leibenstein, Theory of Profit by Knight, Theory of Social change by Everett Hagen.Case study on related topics.

Unit III **Contact Hours: 12**

Entrepreneurship development: Entrepreneurial Competencies, Developing competencies, concept of entrepreneurship development, Entrepreneur Training and developing, Role of Entrepreneur development Programs (EDP), Role of DIC, EDII, NIESBUD, NEDB, EDP – Objectives – contents – methods – execution, Mudra Yojna: Shishu, Kishore and Tarun Scheme. Role of Mentors. Innovation and Entrepreneurship, Design Thinking Process, Role of consultancy organizations in promoting Entrepreneurs, Problems and difficulties of Entrepreneurs – Marketing Finance, Human Resource, Production; Research – external problems, Mobility of Entrepreneurs,Entrepreneurial change, occupational mobility – factors in mobility.Case study on related topics.

Unit IV **Contact Hours: 12**

Role of Central government and State Government in promoting Entrepreneurship:Introduction to various incentives, subsidies and grants, Export Oriented Units, Fiscal and Tax concessions available, Women Entrepreneurs – Role, Problems and Prospects, Reasons for low women Entrepreneurs, Assistance Programme for Small Scale Units – Institutional Framework – Role of SSI Sector in the Economy – SSI Units – Failure, Causes and Preventive Measures – Turnaround Strategies. Future of Entrepreneurship Development and Government, Start Up India, Make in India.Case study on related topics.

Unit V **Contact Hours: 12**

Enterprise Promotion: Creating Entrepreneurial Venture, Entrepreneurship Development Cycle, Business Planning Process The business plan as an entrepreneurial tool, Elements of Business Plan, Objectives, Market Analysis, Development of product/ idea –Resources, Capabilities, and strategies, identifying attributes of strategic resources, Opportunity Analysis, innovator or imitator, SWOT analysis, Internal and External Environment Analysis, Industry Analysis, Embryonic Companies and Spin off's, Porter's five forces model, Identifying the right Business Model Canvas, Seven Domains of John Mullins, Opportunities in Emerging/Transition/Decline industries, Opportunities at the bottom of the pyramid, Opportunities in social sector, Opportunities arising out of digitization, Marketing, Finance, Organization & Management, Ownership – Franchising, networking and alliances, Buying an existing business, Critical risk contingencies of the proposal, Scheduling and milestones.Case study on related topics.

Text Books:

1. Vasant Desai (2011), Dynamics of Entrepreneurship Development, Himalaya Publishing House.
2. David H. Holt, (1991) Entrepreneurship: New Venture Creation, Prentice Hall.
3. K. Nagarajan, (2017) Project Management, New Age International Pvt Ltd.

Reference book:

1. The Culture of Entrepreneurship, Brigitte Berger.
2. Entrepreneurship: Strategies and Resources, Marc J, Dollinger.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
PHY205B (Elective)	Intellectual Property Right	4	-	70	30	100

Objectives

1. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries and Research.
2. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects
3. To disseminate knowledge on copyrights and its related rights and registration aspects
4. To disseminate knowledge on trademarks and registration aspects
5. To disseminate knowledge on Design, Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
6. Too aware about current trends in IPR and Govt. steps in fostering IPR and case studies.

Unit-I Overview and Introduction of Intellectual Property 12 Hrs

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994, Phonograms or Geneva Convention, History of IPR.

Unit-II Patents and Drafting 12 Hrs

Patents - Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board, Patent Filing and Drafting Case studies, Patent Agents role in India.

Unit-IIICopyrights in IPR 12 Hrs

Nature of Copyright - Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and license of copyright - Infringement, Remedies &Penalties – Related Rights - Distinction between related rights and copyrights, Filing and Drafting the Copyrights.

Unit-IV Trademarks and Trading licenses **12 Hrs**

Concept of Trademarks - Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non-Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademark's registry and appellate board, Trading license importance of exports and imports in trading.

Unit-V IP transactions; Enforcement of IP, Commercialization **12 Hrs**

Implications of Intellectual Property Rights in promoting innovations and their commercialization; technology transfer, Due diligence in patent transactions. Working of patents in India Compulsory license and its implications; Enforcement of Patents against infringer.

Industrial Designs Registrations: Classification, Protection and Enforcement of Industrial Designs in Indian. Registration and protection of design in India and abroad.

Geographical Indications: Concept of Geographical Indications and GI registration in India; Global scenario of GI. Protection of Traditional Knowledge and development of balanced benefit sharing models; management of GI to enhance the economic returns from GIs. Enforcement of GI. GI registrations process in India Case studies. Case Studies and Discussions related to IPR

TEXT AND REFERENCE BOOKS:

1. Rimmer, M. (2008). Intellectual property and biotechnology: biological inventions. Edward Elgar Publishing.
2. Singh, H. B., Jha, A., &Keswani, C. (Eds.). (2016). Intellectual property issues in biotechnology. CABI.
3. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.
4. Neeraj, P., &Khusdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.

Learning Outcomes

1. The students once they complete their academic projects, shall get an adequate knowledge on patent and copyright for their innovative research works during their research career, information in patent documents provide useful insight on novelty of their idea from state-of-the art search.
2. This course provides further way for developing their idea or innovations.
3. To Pave the way for the students to catch up Intellectual Property (IP) as a career option a. R&D IP Counsel b. Government Jobs – Patent Examiner c. Private Jobs d. Patent agent and Trademark agent e. Entrepreneur

E-resources:

1. Subramanian, N., &Sundararaman, M. (2018). Intellectual Property Rights – An Overview. Retrieved from http://www.bdu.ac.in/cells/ipr/docs/ipr-eng-ebook.pdf

2. 2. World Intellectual Property Organisation. (2004). WIPO Intellectual property Handbook. Retrieved from https://www.wipo.int/edocs/pubdocs/en/intproperty/489/wipo_pub _489.pdf

   Reference Journal: 1. Journal of Intellectual Property Rights (JIPR): NISCAIR http://nopr.niscair.res.in/handle/123456789/45 (Case Studies)

Useful Websites:

1. Cell for IPR Promotion and Management (http://cipam.gov.in/)
2. World Intellectual Property Organisation (https://www.wipo.int/about-ip/en/)
3. Office of the Controller General of Patents, Designs & Trademarks (http://www.ipindia.nic.in/)

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY206P	Fortran and Numerical Analysis Laboratory	-	2	30	20	50

FORTRAN and Numerical Analysis Laboratory (MPHY206P)

Objectives

The course aims to introduce students to a wide variety of numerical techniques which are useful for solving problems in various areas of application. While the practical aspects of the subject will be emphasized in the mathematics laboratory, the students will be encouraged to investigate the theoretical limitations of the various methods.

Learning Outcomes

At the end of this module the student should:

1. Be familiar with elementary numerical methods for interpolation, function approximation, integration, the solution of ordinary differential equations, the solution of linear equations and matrix inversion, and the calculation of eigenvalues and eigenvectors;
2. Understand the theory behind these methods;
3. Be able to apply these methods to find numerical approximations and error estimates in a range of problems.

List of Experiments

1. To solve simultaneous Linear equation by Gauss Elimination method.
2. To calculate the root of a transcendental equation by Newton – Raphsons method.
3. Solving the system of linear simultaneous equation by Gauss Serdel method.
4. Numerical Integration by Simpson’s 1/3 Rule.
5. Solving simultaneous Linear equation by Gauss-Jordon method.
6. Solution of Differential equation by Euler’s Method.
7. To invert a given matrix by Gauss-Jordon Method.
8. Solution of Differential equation by RungeKutte Method.
9. To fit the given data in a straight line by linear regression Method.
10. WAP to find the Largest of n numbers of series.
11. To calculate the standard deviation of a given set of data.
12. To write a program to compute the complex roots of a given polynomial of N^{th} degree by Grafffe’s Method.

13. To write a program to compute the Eigen values of a given matrix.
14. To integrate a given function by: (a) Trapezoidal method or by (b) Gauss Quadrature.
15. To find solutions of Ist order, ordinary differential equation by Taylor method.

Course Outcomes (COs):

CO1	The lab will run similar to the Computational Techniques course.
CO2	The objective of the lab is to implement the numerical techniques developed in the course to problems of engineering interest.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY207P	Electronics Laboratory – II	-	2	30	20	50

Electronics Laboratory – II (MPHY207P)

Objectives

The objectives are to study

1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
2. To prepare students to perform the analysis and design of various digital electronic circuits.

Learning Outcomes

After studying this course, the students would gain enough knowledge

1. Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
2. To understand and examine the structure of various number systems and its application in digital design.
3. The ability to understand, analyze and design various combinational and sequential circuits.
4. Ability to identify basic requirements for a design application and propose a cost-effective solution.
5. The ability to identify and prevent various hazards and timing problems in a digital design.
6. To develop skill to build, and troubleshoot digital circuits.

List of Experiments

1. Study of R-S, D/T, J-K Flip-Flops.
2. Study of counters: Ripple, Mode 3, Mode 5 counters.
3. Study of Shift Register.
4. Study of R-2R D/A Converter.
5. Study of Random Access Memory (RAM) Read Only Memory. (ROM)
6. Study of A/D Converter.
7. Experiment with Microprocessor: (a) Convert BCD in to HEXADECIMPL, (b) To transfer group of date blocks from one location to another location.

8. Experiment with microprocessor: (a) to write programs for addition of two 1 byte data giving results of 2 bytes. (b) To write programs for multiplication of two 1 byte data giving results of 2 bytes.
9. (a)To add 2 16-BIT numbers stored in locations from x xxx to x xxx + 3 and add them store the results from x xxx + 4 to x xx x+6 memory location. (b) To find the largest of n numbers of a series.
10. To arrange N numbers in an ascending order.
11. Experiments with Microprocessor: (a) Convert BCD in to binary and vice-versa, (b) To transfer group of data blocks from one location to another location, (c) To write programs for addition of two 1byte data giving result of 2byte data, and (d) To write programs for multiplication of two 1-byte data giving result of 2byte data.
12. Logic gate study DTL and RTL.
13. Study of adder/subtractor.
14. Study of Op-Amp.-IC-741 is inverting/ non inverting amplifier and draw frequency response curve.
15. Construction of Schmitt triggers using IC-741 and study of its characteristics.
16. Study of Astable and monostable Multi Vibrator using IC 555.
17. Digital electronics experiments on bread board using IC-7400.

Course Outcomes (COs):

CO1 Solving tutorial problems based on above topics.

CO2 Performing laboratory experiments/project on above topics/concepts to realize the physics behind them.

Semester – III

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY301	Quantum Mechanics – II	4	-	70	30	100

Objectives

To understand the concepts of the time-dependent perturbation theory and their applications to physical situations.To understand the basics of scattering theory.

Learning Outcomes

1. The students will be able to grasp the concepts of spin arising naturally from the Dirac equation.
2. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics.

Unit-I **12 Hrs**

Variational method, expectation value of energy, application to excited states, ground sate of He-atom, Vander-waals interaction, the W.K.B. approximation, approximate solutions, asymptotic nature of the solution, solution near turning point, connection formulae, energy levels of a potential well and quantization rule, Eikonal approximation.

Unit -II **12 Hrs**

Theory of scattering: differential and total scattering cross section, wave mechanical picture of scattering & the scattering amplitude, green's functions and formal expression for scattering amplitude, The Born approximation and its validity, Partial wave analysis, asymptomatic behavior of partial waves and phase shifts, optical theorem, scattering by a square well potential, scattering by a hard sphere, scattering by a Coulomb potential.

Unit – III **12 Hrs**

Time-dependent perturbation theory, first order perturbation, Harmonic perturbation, Fermi`s Golden rule, Ionization of a H-atom, absorption and induced emission, Selection rules. Identical particles, symmetric and anti-symmetric wave functions

Unit –IV **12 Hrs**

Relativistic quantum mechanics, formulation of relativistic quantum theory, the Klein-Gordon equation; plane wave solutions, charge and current densities, The Dirac equation for a free particle, matrices alpha and beta, Lorentz covariance of the Dirac equation, free particle solutions and the energy spectrum, charge and current densities.

Unit-V **12 Hrs**

The spin of the Dirac particle, Dirac particle in electromagnetic fields and the significance of the negative energy state, Dirac equation for a central field: Spin angular momentum, approximate reduction, spin –orbit energy, separation of equation, the hydrogen atom, classification of energy levels and negative energy states.

TEXT AND REFERENCE BOOKS –

1. L.I. Schiff: Quantum Mechanics (McGraw-Hill).
2. S. Gasiorowicz: Quantum Physics (Wiley).
3. Landau and Lifshitz: Quantum Mechanics.
4. B. Craseman and Z. D. Powell: Quantum Mechanics (Addison Wesley)
5. A.P. Messiah: Quantum Mechanics.
6. J.J. Sakurai: Modern Quantum Mechanics.
7. Mathews and Venkatesan: Quantum Mechanics.
8. Bjorken and Drell :Relativstic Quantum Mechanics.

Course Outcomes (COs):

CO1 Learning approximation methods for bound states, i.e., perturbation theory, variation method and WKB approximation method with their application to physical problems.

CO2 Understanding the concepts of time dependent perturbation theory, adiabatic and sudden approximation, absorption and induced emission, transition probability and Einstein's A and B coefficients.

CO3 Studying physical concepts of the theory of scattering and its applications.

CO4 Exploring the application of Schrodinger's and Dirac's relativistic equations in understanding negative energy states and hyperfine splitting of energy states.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY302	Plasma Physics	4	-	70	30	100

Objective

The course describes single particle plasma physics, collisions and electrical conductivity, kinetic theory in plasma physics, magnetohydrodynamics, flows and boundaries, and plasma waves. The course conveys the different levels of developing a dynamical theory for space plasma: Single particle motion, kinetic theory and magnetohydrodynamics.

Learning Outcomes

1. Motionof charged particles in the magnetosphere and ionosphere.
2. Trappedparticles and their motions.
3. Collectivemotion of charged particles.
4. Derivationof governing equations in plasma physics (kinetic and fluid description)
5. Maxwell's equations and propagation of different types of waves.

Unit – I **12 Hrs**

Occurrence of Plasmas in Nature, Definition of Plasma, Concept of Temperature, Debye Shielding, The Plasma Parameter, Criteria for Plasmas, Applications of Plasma Physics.

Unit – II **12 Hrs**

Uniform E and B Fields, Nonuniform B Field, Nonuniform E Field, Time-Varying E Field, Time-Varying B Field, Summary of Guiding Center Drifts, Adiabatic Invariants. Relation of Plasma Physics to Ordinary Electromagnetics, The Fluid Equation of Motion, Fluid Drifts, Perpendicular to B, Fluid Drifts Parallel to B, The Plasma Approximation

Unit – III **12 Hrs**

Representation of Waves, Group Velocity, Plasma Oscillations, Electron Plasma Waves, Sound Waves, Ion Waves, Validity of the Plasma Approximation, Electrostatic Electron Oscillations Perpendicular to B, Electrostatic Ion waves Perpendicular to B, The Lower Hybrid Frequency, Electromagnetic Waves with $B_0 = 0$, Electromagnetic Waves Perpendicular to B_0, Cutoffs and Resonances, Electromagnetic Waves Parallel B_0, Hydromagnetic Waves, Magneto-sonic Waves, The CMA Diagram,

Unit – IV **12 Hrs**

Diffusion and Mobility in Weakly Ionized Gases, Decay of a Plasma by Diffusion, Steady State Solutions, Recombination, Diffusion across a Magnetic Field, Collisions in Fully Ionized Plasmas, The Single-Fluid MHD Equations, Diffusion in Fully Ionized Plasmas, Solutions of the Diffusion Equation, Bohm Diffusion and Neoclassical Diffusion.

Unit – V **12 Hrs**

Hydromagnetic Equilibrium, The Concept of β , Diffusion of Magnetic Field into a Plasma, Classification of Instabilities, Two-Stream Instability, The "Gravitational" Instability, Resistive Drift Waves, The Weibel Instability, The Meaning of f(v), Equations of Kinetic Theory, Derivation of the Fluid Equations, Plasma Oscillations and Landau Damping, The Meaning of Landau Damping, Physical Derivation of Landau Damping, Modes BGK and Van Kampening, Experimental Verification, Ion Landau Damp, Kinetic Effects in a Magnetic Field.

TEXT AND REFERENCE BOOKS:

1. Introduction to Plasma Physics: F.F Chen Plenum Pres New - York
2. Introduction to Plasma Theory: D. R. Nicholson, John - Wiley & Son
3. Fundamental of Plasma Physics: J. A. Bittencourt

Course Outcomes (COs):

CO1 Define, using fundamental plasma parameters, under what conditions an ionized gas consisting of charged particles (electrons and ions) can be treated as plasma.

CO2 Distinguish the single particle approach, fluid approach and kinetic statistical approach to describe different plasma phenomena.

CO3 Determine the velocities, both fast and slow (drift velocities), of charged particles moving in electric and magnetic fields that are either uniform or vary slowly in space and time.

CO4 Explain the physical mechanism behind Landau damping and make calculations in this area using kinetic theory.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY303	Atomic & Molecular Physics	4	-	70	30	100

Objectives

To give a broad knowledge of the most important characteristics of atoms, molecules and the interaction with electromagnetic fields.

Learning Outcomes

On completion of the course the student should have the following learning outcomes defined in terms of knowledge, skills and general competence:

1. The structure and dynamics of atoms and simple molecules.
2. The interaction between atoms, molecules and electromagnetic fields.
3. Collision processes involving atoms, charged particles and molecules.
4. The structure of the periodic system, many-electron and relativistic effects.
5. Apply physics and mathematics to solve the Schrödinger equation and the Dirac equation for hydrogen-like atoms.
6. Explain the buildup of multi-electron atoms and simple molecules and their characteristics.
7. Apply quantum mechanics to compute characteristic quantities related to atomic structure, fragmentation and radiation, analytically and based on numerical methods and programs.

Unit-I **12 Hrs**

Quantum states of one electron atoms-atomic orbitals, Hydrogen spectrum, spin-orbit(l-s) interaction energy, fine structure of hydrogen spectrum including l-s interaction and relativistic correction, spectra of alkali elements, fine structure in alkali spectra, penetrating and non-penetrating orbits, intensity rules.

Unit-II **12 Hrs**

Pauli's principle, equivalent and non-equivalent electrons, ground state (basic level of different elements), two electron systems, interaction energy in L-S and J-J Coupling, Hyperfine structure, line broadening mechanisms (general ideas).

Unit–III **12 Hrs**

Normal and anomalous Zeeman effect, early discoveries and developments, vector models of one electron system in a weak magnetic field, magnetic moment of a bound electron, magnetic interaction energy, selection rules, intensity rules, Paschen-Back (PB) effect – principal series effect, Zeeman and PB effects in hydrogen, Stark effect- discovery, Stark effect in Hydrogen, orbital model, weak and strong effect in Hydrogen.

Unit-IV **12 Hrs**

Types of molecules: linear and diatomic molecules, symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules: rigid rotator model, energy levels, Eigen functions, spectrum, comparison with observed spectrum and non-rigid rotator model, Intensities of spectral lines, microwave spectrometer, Raman spectrum; classical and quantum theory of Raman Effect, pure rotational Raman spectrum.

Unit –V **12 Hrs**

Vibrational spectra of diatomic molecules: simple harmonic model, energy levels and spectrum, comparison with observed spectrum and anharmonic model, Vibrating rotators, Interaction of rotations and vibrations, fine structures and P-Q-R branches, IR spectrometer, Vibrational Raman spectrum, Vibrational rotational Raman spectrum.

TEXT AND REFERENCE BOOKS:

1. Introduction to atomic spectra - H.E. White (T).
2. Fundamentals of molecular spectroscopy – C.N. Banwell and E.M McCash (T).
3. Spectroscopy vol. I, II and III – Walker and straughner.
4. Introduction to Molecular spectroscopy – G.M. Barrow.
5. Spectra of diatomic molecules – Herzberg.
6. Molecular spectroscopy – Jeanne L.Mc-Hale.

Course Outcomes (COs):

CO1 To explain the quantum states of one electron and two electron systems, interaction energy in LS & JJ couplings, hyperfine structure and broadening mechanisms.

CO2 Understanding the types of molecules, energy levels and intensity of their rotational spectra.

CO3 Understanding vibrational spectra of diatomic molecules with inputs of energy levels and operation of IR spectrometer.

CO4 Learning the concepts, techniques and instrumentation of ultraviolet, visible and infrared spectroscopy such as Raman, Photoelectron, Photo acoustic, Mossbauer and NMR spectroscopy.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY304A (DSE 1)	Solid State Physics	4	-	70	30	100

Objectives

To provide extended knowledge of principles and techniques of solid-state physics.To provide an understanding of structure, thermal and electrical properties of matter.

Learning Outcome

The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials; and develop an understanding of relation between band structure and the electrical/optical properties of a material.

Unit- I **12 Hrs**

Electrons in Solids and Electronic Properties, Energy bands nearly free electron model, origin of energy gap and its magnitude, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, restatement of Bloch theorem, crystal moment of an electron, solution of Central equation, Kronig-Penny model in reciprocal space, empty lattice Approximation, approximate solution near zone boundary, Number of orbitals in a band, metals and insulators.

Unit –II **12 Hrs**

Fermi surfaces and metals Effect of temperature on F-D distribution, free electron gas in three dimensions. Different zone schemes, reduced and periodic zones, construction of Fermi surfaces, nearly free electrons, electron, hole, open orbits, Calculation of energy bands, Tight binding, Wigner-Seitz, cohesive energy, pseudo potential methods. Experimental methods in Fermi surface studies, quantization of orbits in a magnetic field, de Haas van Alphen Effect, External orbits, Fermi surface of copper.

Unit- III **12 Hrs**

Crystal vibration and thermal properties, Lattice dynamics in monoatomic and diatomic lattice: two atoms per primitive basis, optical and acoustic modes, quantization of elastic waves, phonon momentum, inelastic neutron scattering by phonons, Anhormonic crystal interactions-thermal expansion, thermal conductivity, thermal resistivity of phonon gas, umklapp processes, imperfections.

Unit –IV **12 Hrs**

Electron-Phonon interaction- superconductivity, Experimental survey: occurrence of superconductivity, Destruction of superconductivity by magnetic field, Meissner effect, heat capacity, energy gap, MW, and IR properties, isotope effect. Theoretical survey: thermodynamics of superconducting transition, London equation, Coherence length, Cooper pairing due to phonons, BCS theory of superconductivity, BCS ground state, flux quantization of superconducting ring, duration of persistent currents, Type II superconductors, Vortex states, estimation of Hc1 and Hc2, single particle and Josephson superconductor tunneling, DC/AC Josephson effect, Macroscopic quantum interference. High temperature superconductors, critical fields and currents, Hall number, fullerenes ring.

Unit – V **12 Hrs**

Semiconductor crystals, Band gap, equation of motion, physical derivation of equation of motion, holes, effective mass, physical interpretation of effective mass, effective masses of semiconductors Si and Ge, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor and acceptor states, thermal ionization of donors and acceptors, thermo-electric effects.

TEXT AND REFERENCE BOOKS

1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons).
2. J. M. Ziman: Principles of theory of solids (Cambridge Univ.Press).
3. Azaroff: X-ray crystallography.
4. Verma and Srivastava: Crystallography for Solid State Physics.
5. Buerger: Crystal Structure Analysis.
6. Thomas: Transmission Electron Microscopy.
7. Omar: Elementary solid-state physics.
8. Chalking and Lubensky: Principles of Condensed Matter Physics.
9. Madelung: Introduction to solid-state theory.
10. Callaway: Quantum theory of solid-state physics.
11. Huang: Theoretical Solid-State Physics.

Course Outcomes (COs):

- CO1 To understand interaction of x-rays with matter, x-ray diffraction for structure determination, defects in solids and the electron microscopic techniques.
- CO2 Learning band theory of solids, classification of solids, concept of effective mass, Fermi surface and de Hass von Alfven effect.
- CO3 Understanding atomic and molecular polarizability, quantum Hall effect, magneto resistance, superconductivity and the general idea of high T_c superconductivity.
- CO4 Explaining magnetic properties of solids, Optical reflectance, Photo electromagnetic effect, Faraday effect and the elements of Raman effect in solids.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY304B (DSE 1)	Experimental Physics	4	-	70	30	100

Objectives

This course involves teaching sessions that may be attended by both Undergraduate and Postgraduate students. This is a laboratory-based course in selected areas including atomic and nuclear physics, optics, astrophysics and electromagnetism, plus a practical analogue electronics course.

Learning Outcomes

On completion of this course, students should be able to:

1. Use transistors, operational amplifiers and phase sensitive detection;
2. Describe at least two of the following effects:
   - Fourier methods in optics
   - Thermal diffusivity
   - Reflection from terminated or unterminated transmission lines
   - Alpha radiation
   - Gamma radiation
   - Electron spin resonance;
3. Connect a digital oscilloscope to a computer and record a signal with an appropriate sampling rate.
4. Generate and interpret the power spectrum of the recorded data,
5. Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
6. Demonstrate advanced communication skills in the context of Physics.

Unit – I **12 Hrs**

Data interpretation and analysis; Precision and accuracy, error analysis, propagation of errors, least squares fitting, linear and nonlinear curve fitting, chi-square test.

Unit – II **12 Hrs**

Dispersion and resolution of a prism and a grating spectrometer, Single and double monochromators, Photomultiplier tube, Charge coupled detectors (CCD).

Unit – III **12 Hrs**

UV and Visible absorption spectroscopy, IR and Raman spectroscopy, Electron Backscatter Diffraction, Wide Angle Diffraction, Reflectometry, Soft X- Rays and Magnetic Scattering, Spectroscopic Techniques.

Unit – IV **12 Hrs**

Element Distribution Analysis, Element Depth Profile Analysis, Stress Measurement Techniques, Stress and Strain, Substrate Curvature, Measurement Techniques and Fourier Transform Infrared Spectroscopy (FTIR) analysis.

Unit – V **12 Hrs**

Basics of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy, Mössbauer spectroscopy, Microwave spectroscopy, Photoacoustic spectroscopy and their applications. Laser as a source of radiation and its characteristics, Laser fluorescence and absorption spectroscopy, Multiphoton ionization and separation of isotopes.

TEXT AND REFERENCE BOOKS:

1. Spectroscopy Volume 1, 2 and 3: B.P. Straughan and S. Walker.
2. Modern Spectroscopy: J.M. Hollas.
3. Transmission Electron Microscopy of Metals: Gareth Thomas
4. Elements of X-ray Diffraction: Bernard Dennis Cullity.
5. Atomic Force Microscopy/Scanning Tunneling Microscopy: M.T. Bray, Samuel H. Cohen and Marcia L. Lightbody.
6. Electron Spectroscopy: Theory, Techniques and Applications: CR Brundle and AD Baker.
7. Synchrotron Radiation: Techniques and Applications: C. Kunz.
8. Low Energy Electron Spectroscopy: KD Sevier.
9. Radiation Detectors: WH Tait.
10. Advances in Image Pickup and Display, Vol. 1: P. Schagen.
11. Metal Based Thin Films for Electronics: Editor(s): PD Dr. rer. nat. habil. Klaus Wetzig PD Dr. rer. nat. habil. Claus M. Schneider, First published:28 January 2005, Wiley- VCH Verlag GmbH & Co. KGaA

Course Outcomes (COs):

CO1 Assemble and document a relevant bibliography for a physics experiment.
CO2 Prepare a journal-style manuscript using scientific typesetting software.
CO3 Plan and conduct experimental measurements in physics while employing proper note-taking methods.
CO4 Calculate uncertainties for physical quantities derived from experimental measurements.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY305A (DSE 2)	Astronomy & Astrophysics	4	-	70	30	100

Objectives

The programme emphasizes theoretical understanding in astrophysics and practical application of mathematics, physics, computer science, and statistics to solve astronomical problems. As part of the programme, you will produce a thesis, where you can immerse yourself in either cosmology, extragalactic astronomy, or solar physics. The Institute houses international top-level research groups in these fields.

Learning outcomes

1. The aim of research and teaching is to understand astrophysical processes and systems, ranging from our own sun to stars, galaxies and the whole universe.
2. Large numerical simulations and analysis of observational data are important tools.
3. The master's programme in Astronomy is for those who want to use proficiency in physics, mathematics, computer science, and statistics to get a new understanding of the universe.

Unit – I ASTRONOMICAL INSTRUMENTS & BASIC PHYSICS 12 Hrs.

Light and Its Properties, The Earth's Atmosphere and the Electromagnetic Radiation, Optical Telescopes, Radio Telescopes, The Hubble Space Telescope, Astronomical Spectrographs, Photographic Photometry, Photoelectric Photometry, Spectrophotometry, Detectors and Image Processing, Basic Physics: Concept of Radiation.

Unit – II MAGNITUDES, MOTIONS, DISTANCES OF STARS & SPECTRAL CLASSIFICATION OF STARS 12 Hrs.

Stellar Magnitude Sequence, Absolute Magnitude and the Distance Modulus, The Bolometric Magnitude, Different Magnitude Standards, The UBV System and Six-color Photometry, Radiometric Magnitude, The Color-index of a Star, Luminosities of Stars and Stellar Parallax. Boltzmann's Formula, Saah's Equation of Thermal ionization, Harvard System of Spectral Classification: The Henry-Draper Catalogue, The Luminosity Effect on Stellar Spectra, Importance of ionization Theory in Astrophysics, Spectroscopic Parallax, The Hertzsprung-Russell Diagram.

Unit – III THE SUN 12 Hrs.

Sun, The Photosphere: Limb-darkening, Solar Granulation, Faculac, The Chromosphere, Solar Corona, Prominences, The 11-year Solar Cycle and Sunspots, The Solar Magnetic Fields, Theory of Sunspots, Solar Flares, Radio Emission from the Sun, Solar Wind, The Solar Neutrino Puzzle.

Unit – IV STARS & ITS LIFE CYCLES 12 Hrs.

End states of stars, degenerate states, White dwarfs, and Chandrasekhar limit, Neutron stars and Pulsars, Black holes. Binary stars and their classification, close binaries, Roche Lobes, Evolution of semidetached systems: Algol's, Cataclysmic variables and X-ray binaries.

Unit – V GALACTIC NEBULAE & INTERSTELLAR MATTER 12 Hrs.

Classification and Galactic Distribution of Nebulae, Observational Techniques, Dark Nebulae, Reflection Nebulae, Diffuse Emission and Crab Nebula.

Large-scale Distribution of Interstellar Matter, Interstellar Lines, Interstellar Clouds, H I and H II Regions, Interstellar Shock Waves, Interstellar Cloud Collisions, Energy Balance in Interstellar Gas, The Intercloud Medium, interstellar Grains.

TEXT AND REFERENCE BOOKS:

1. Modern Astrophysics, B.W. Carroll and D. A. Ostlie, Addison-Wealey publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th edition, Saunders college publishing.
3. Theoretical Astrophysics, vol. – II: Stars and stellar systems, T. Padmanabhan, Cambridge university press.
4. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University science books.
5. The new cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
6. Quasars and active galactic neuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge university press.
7. Theoretical Astrophysics, vol. I: Astrophysical processes T.Padmanabhan, Cambridge university press.
8. Galactic Astronomy: Binney and Merrifield.
9. An Introduction to Astrophysics: B. Basu, PHI

Course Outcomes (COs):

CO1 Apply conservation laws to predict astrophysical phenomena.
CO2 Recognize the impact of high-energy phenomena upon the evolution of the Universe.
CO3 Assess astrophysical threats to the Earth and potential mitigation.
CO4 Present current astronomical research in written, visual, and verbal format to an audience of your peers.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY305B (DSE 2)	Nanotechnology: Principles & Practices	4	-	70	30	100

Objectives

To foundational knowledge of the Nanoscience and related fields. To make the students acquire an understanding the Nanoscience and Applications. To help them understand in broad outline of Nanoscience and Nanotechnology.

Learning Outcomes

After completing this course students will be able to:

1. Learn about the background on Nanoscience
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment.
3. Apply their learned knowledge to develop Nanomaterial's.

Unit – I Structure and Bonding **12 Hrs.**

Introduction, Arrangement of Atoms, Two-Dimensional Crystal Structures, Three-Dimensional Crystal Structures, Planes in the Crystals, Crystallographic Directions, Reciprocal Lattice, Quasi Crystals, Liquid Crystals, Bonding in Solids, Electronic Structure of Solids.

Unit – II Synthesis of Nanomaterials—I (Physical Methods) **12 Hrs.**

Introduction, Mechanical Methods, Methods Based on Evaporation, Laser Vapourization, Sputter Deposition, Chemical Vapour Deposition, Electric Arc Deposition, Ion Beam Techniques, Molecular Beam Epitaxy (MBE)

Unit – III Synthesis of Nanomaterials—II (Chemical Methods) **12 Hrs.**

Introduction, Colloids and Colloids in Solutions, Nucleation and Growth of Nanoparticles, Synthesis of Metal Nanoparticles by Colloidal Route, Synthesis of Semiconductor Nanoparticles by Colloidal Route, Langmuir-Blodgett (LB) Method Microemulsions, Sol-Gel Method, Hydrothermal Synthesis, Sonochemical Synthesis, Microwave Synthesis, Synthesis Using Micro-reactor or Lab-On-Chip.

Unit - IV Synthesis of Nanomaterials—III (Biological Methods) & Self-Assembly 12 Hrs.

Introduction, Synthesis Using Microorganisms, Synthesis Using Plant Extracts, Use of Proteins, Templates Like DNA, S-Layers etc., Synthesis of Nanoparticles Using DNA, Further Reading, Self-Assembly: Introduction, Mechanism of Self Assembly, Some Examples of Self Assembly.

Unit – V Analysis Techniques 12 Hrs.

Microscopes, Scanning Electron Microscope, Transmission Electron Microscope (TEM), Scanning Probe Microscopes (SPM), Diffraction Techniques, Spectroscopies, Magnetic Measurements, Mechanical Measurements.

TEXT AND REFERENCE BOOKS:

1. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices, Springer.
2. B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience and Nanotechnology, Springer-Verlag Berlin Heidelberg.
3. Pradeep T., Nano: The Essentials, 1st Edition, Mc Graw Hill, 2007.
4. Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, Nanoscale
5. Science and Technology, John Wiley & Sons, Ltd., 2005.
6. Yong Zhou, Nanomaterials and Nanotechnology, Nova Publishers 2009.
7. Charles P. Poole Jr and Frank J. Owens, Introduction to Nanotechnology, Wiley Interscience, 2007.
8. Chris Binns, Introduction to Nanoscience & Nanotechnology, 1st Edition, Willey-Publication, 2010.
9. Chattopadhay K.K., Introduction to Nanoscience and Nanotechnology, APH Publishing Corporation, 2006.
10. Parag Diwan, Handbook of Nanotechnology, Pentagon Press, 2009.

Course Outcomes (COs):

CO1	Explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nanoscale.
CO2	Choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.
CO3	Correlate properties of nanostructures with their size, shape and surface characteristics.
CO4	Appreciate enhanced sensitivity of nanomaterial-based sensors and their novel applications in industry.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY304A(P)	Solid State Physics Laboratory	-	2	30	20	50

Solid State Physics Laboratory (MPHY304A(P))

Objectives

The course will concentrate on four experiments in solid state physics covering a broad range of topics representative of the field. For each experiment, students will receive a handout that briefly outlines the theory, procedure and analysis expected. However, the student is expected to research the topic of the experiment in depth and produce an experiment proposal before attempting data collection. After the experiment is completed, each student will write a report that includes experimental results, and analysis and discussion of these results.

Learning Outcomes

1. Experimental techniques pertinent to studies in condensed matter physics.
2. Interpreting results, error analysis, writing reports, analyzing data.
3. Last but not least: learning more advanced physics topics, not encountered at the introductory level.

List of Experiment

1. Determination of band gap of semiconductor by four probe methods.
2. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration.
3. To study Electron Spin (ESR) Resonance in given experimental material.
4. To study I-V characteristics of photovoltaic solar cell and find the efficiency.
5. To study the decay of photoconductivity of given sample and find out trap depth.
6. Study of decay of photoluminescence of a given sample.
7. Measurement of electrical conductivity using Impedance Spectroscopy technique.
8. To determine drift velocities of Ag^+ ion in AgI from temperature dependence of ionic transference number study.
9. Electrical conductivity of Ball milled/Mechano-chemical synthesized materials.
10. Structural analysis of powder sample by XRD and particle size determination using Scherrer's formula.
11. FTIR studies of solid samples.
12. Mechanoluminescence of sucrose crystals.
13. Thermoluminescence of irradiated samples.

Course Outcomes (COs):

CO1	Explain the basic concepts that are used to describe the structure and physical properties of crystalline substances.
CO2	Use physical models to perform calculations of the properties of solids.
CO3	Give an overview of an application related to the physical phenomena treated in the course.

Subject Code	Name of the Subject	Credit Scheme		Examination		
		T	P	Theory/ Practical	Internal	Total
MPHY306P	Minor Project	-	2	150	50	150

Minor Project (MPHY306P) **90 Hrs**

Objectives

Minor Project envisages that a student during the final semester will acquire the ability of applying the basic knowledge to a practical problem. A student is required to carry out the project work related to Physics, under the guidance of a faculty member and/or the supervisor of the concerned industry/institute/organization.

Learning Outcomes

At the end of this course students will be able to …

1. Identify an open-ended problem in area of Physics which requires further investigation.
2. Identify the methods and materials required for the project work.
3. Manage the work with team members.
4. Formulate and implement innovative ideas for social and environmental benefits.
5. Analyze the results to come out with concrete solutions.
6. Write technical report of the project apart from developing a presentation.

Minor Project Report	:	30 Marks
Presentation	:	20 Marks
Comprehensive viva-voce	:	20 Marks
Internal assessment	:	30 Marks
Total	**:**	**100 Marks**

Note: Minor Project of Semesters III is interest of field/elective course. Student has to opt for any one of the courses. The commencement of any one of the minor projects is subjected to the availability of basic infrastructural facilities viz. expert faculty, laboratory etc.

Course Outcomes (COs):

CO1 Carrying out a job oriented minor project as per program framework on a contemporary topic of public importance.

CO2 Preparing a Dissertation containing different aspects of the project with important conclusions.
CO3 Learning how to prepare a presentation to defend the selection and outcomes of the major project.
CO4 Understanding the important future applications of the minor findings during the course of the project work.
CO5 Undergoing a viva voce of the major project work.

Semester – IV

Subject Code	Name of the Subject	Credit Scheme		Examination		
		L	P	Theory/ Practical	Internal	Total
MPHY401	Major Project / Dissertation	-	28	500	200	700

Objectives

Major Project of envisages that a student during the final semester will acquire the ability of applying the basic knowledge to a practical problem. A student is required to carry out the project work related to Physics, under the guidance of a faculty member and/or the supervisor of the concerned industry/institute/organization.

Learning Outcomes

At the end of this course students will be able to …

1. Identify an open-ended problem in area of Physics which requires further investigation.
2. Identify the methods and materials required for the project work.
3. Manage the work with team members.
4. Formulate and implement innovative ideas for social and environmental benefits.
5. Analyze the results to come out with concrete solutions.
6. Write technical report of the project apart from developing a presentation.

Dissertation	:	300 Marks
Presentation	:	100 Marks
Comprehensive viva-voce	:	100 Marks
Internal assessment	:	200 Marks
Total	**:**	**700 Marks**

Note: Major Project of Semesters IV is interest of field/elective course. Student has to opt for any one of the courses. The commencement of any one of the major projects is subjected to the availability of basic infrastructural facilities viz. expert faculty, laboratory etc.

Course Outcomes (COs):

CO1 Carrying out a job oriented major project as per program framework on a contemporary topic of public importance.

CO2 Preparing a Dissertation containing different aspects of the project with important conclusions.

CO3 Learning how to prepare a presentation to defend the selection and outcomes of the major project.

CO4 Understanding the important future applications of the major findings during the course of the project work.

CO5 Undergoing a viva voce of the major project work.