Mev:- 14/11/24

Proposed SCHEME AND SYLLABI

of

Integrated B.Sc. (Hons/Hons. with Research)-M.Sc. Physics

(under National Education Policy - 2020)

IIIrd to VIth semester w.e.f. academic session (2024-25)

Batch (2023-24)

DEPARTMENT OF PHYSICS

GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY

HISAR-125001, HARYANA

07/11/24

Chairperson
Department of Physics
Guru Jambheshwar University
of Sc. & Tech., Hisar-125001

Vision and Mission of the Department of Physics

Vision:

To inspire the young students towards understanding and learning the fundamental concepts of Physics and their applications for the development of new technologies in the national interests.

Mission:

Physics is regarded as the most significant subject among all scientific and technical disciplines. The mission of Physics department at Guru Jambheshwar University of Science & Technology is to provide both the UG and PG students strong qualitative and quantitative knowledge along with developing a problem-solving attitude that may open a wide range of career choices. In addition, the mission also includes encouraging the research scholars to conduct cutting-edge research resulting in new discoveries and innovations that expands the horizons of science and technology.

This mission will be accomplished by providing students with rigorous and comprehensive knowledge as well as bringing exciting research perspectives to the student community of Physics Department at Guru Jambheshwar University of Science & Technology.

Integrated B.Sc. (Hons/Hons. with Research)-M.Sc. Physics programme:

Integrated B.Sc. (Hons/Hons. with Research)-M.Sc. Physics programme has been started in the year 2023 to attract young bright students to inculcate the culture of research and development in the areas of physical sciences. The scheme and syllabi of the programme is designed as per NEP-2020 with an aim to produce a skilled manpower for conducting high impact research in the academic & industrial organizations, including national research laboratories. Students passing out this programme are expected to serve as scientists at national research laboratories. The essential guidelines from UGC dated 07 Dec 2022 have been followed in the preparation of the course structure of this programme. Students will obtain B.Sc. Physics (Honours) or B.Sc. Physics (Honours with Research) after completing the 4th year upon fulfilling the academic requirements. The multiple entry-exit options will be available on successful completion of stipulated year-wise academic requirements.

Awarding UG Certificate, UG Diploma, and Degrees UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

UG Diploma: Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These 10 Curriculum and Credit Framework for Undergraduate Programmes students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

3-year UG Degree: Students who wish to undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits.

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Scheme of Integrated B.Sc. (Hons/Hons. with Research)-M.Sc. Physics programme under NEP-2020 (w.e.f. 2024-25)

SEMESTER-III

Course Code	Course	Nomenclature	Credits	Hrs/ week	Marks		
					Ext.	Int.	Total
24PHY0301T	Discipline Specific Course (DSC-A3)	Electricity and Magnetism	4	4	70	30	100
24PHY0302T	Discipline Specific Course (DSC-A4)	Mathematical Physics-I	4	4	70	30	100
24PHY0303T	Discipline Specific Course (DSC-A5)	Physics of Semiconductor Devices (Theory)	2	2	35	15	50
24PHY0303P		Physics of Semiconductor Devices (Practical)	2	4	35	15	50
24VOC0328P	Vocational (VOC)	Instrumentation-I Lab	4	8	70	30	100
24MDC0311T	Multidisciplinary Course (MDC3)	Basics of MATLAB	3	3	50	25	75
24AEC0301T	Ability Enhancement Course (AEC3)	English and Effective Communication-II	2	2	35	15	50
24SEC0312T	Skill Enhancement Course (SEC3)	Programming with Python	2	2	35	15	50
24SEC0312P		Programming with Python Lab	1	2	---	25	25
			24	31	400	200	600

Notes:

The Discipline specific course (DSC-A5) is divided into theory and practical parts of 2 credits each i.e., codes 24PHY0303T and 24PHY0303P. Students are separately assessed in these papers and are separately required to obtain minimum pass marks.

(T= Theory/ Lecture, Tut. = Tutorial, P= Practical)

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SEMESTER-IV

Course Code	Course	Nomenclature	Credits	Hrs/ week	Marks		
					Ext.	Int.	Total
24PHY0401T	Discipline Specific Course (DSC-A6)	Elements of Modern Physics	4	4	70	30	100
24PHY0402T	Discipline Specific Course (DSC-A7)	Waves and Optics	4	4	70	30	100
24PHY0403T	Discipline Specific Course (DSC-A8)	Electromagnetic Theory	4	4	70	30	100
24PHY0404T	Discipline Specific Course (DSC-A9)	Basic Instruments in Physics (Theory)	2	2	35	15	50
24PHY0404P		Basic Instruments in Physics (Practical)	2	4	35	15	50
24VOC0428P	Vocational (VOC)	Instrumentation-II Lab	4	8	70	30	100
24AEC0302T	Ability Enhancement Course (AEC4)	संचार कौशल	2	2	35	15	50
23VAC0301T	Value added Course (VAC3)	Environmental Studies-II	2	2	35	15	50
			24	30	420	180	600

Notes:

Students exiting the programme after fourth semester and securing 100 credits including 4 credits of summer internship will be awarded UG diploma in the relevant Discipline/subject.

The Discipline specific course (DSC-A9) is divided into theory and practical parts of 2 credits each i.e., codes 24PHY0404T and 24PHY0404P. Students are separately assessed in these papers and are separately required to obtain minimum pass marks.

(T= Theory/ Lecture, Tut. = Tutorial, P= Practical)

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SEMESTER-V

Course Code	Course	Nomenclature	Credits	Hrs/ week	Marks		
					Ext.	Int.	Total
24PHY0501T	Discipline Specific Course (DSC-A10)	Basic Quantum Mechanics	4	4	70	30	100
24PHY0502T	Discipline Specific Course (DSC-A11)	Mathematical Physics-II	4	4	70	30	100
24PHY0503T	Discipline Specific Course (DSC-A12)	Solid State Physics-I (Theory)	2	2	35	15	50
24PHY0503P		Solid State Physics-I (Practical)	2	4	35	15	50
24PHY0504T	Discipline Specific Course (DSC-A13)	Analog Systems (Theory)	2	2	35	15	50
24PHY0504P		Analog Systems (Practical)	2	4	35	15	50
24PHY0505I	Internship (120 Hrs. (minimum 4 weeks duration))#	Internship	4	-	-	100	100
			20	20	280	220	500

#Four credits of internship earned by a student during summer internship after 2nd or 4th semester will be counted in the fifth semester of a student who pursue 3-year UG programmes without taking exit option.
The internship (120Hrs (minimum 4 weeks duration)) done by a student either inside or outside the institute are assessed by at least two senior teachers of the parent department in the form of presentation and a report submitted by the student which is signed by the internship supervisor of the student. ***Marks will be awarded by the committee out of 100 marks on the basis of report and viva-voce examination.***

The Discipline specific courses (DSC-A12 & DSC-A13) are divided into theory and practical parts of 2 credits each i.e., codes 24PHY0503T, 24PHY0503P & 24PHY0504T, 24PHY0504P respectively. Students are separately assessed in these papers and are separately required to obtain minimum pass marks.

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SEMESTER-VI

Course Code	Course	Nomenclature	Credits	Hrs/ week	Marks		
					Ext.	Int.	Total
24PHY0601T	Discipline Specific Course (DSC-A14)	Classical and Statistical Mechanics	4	4	70	30	100
24PHY0602T	Discipline Specific Course (DSC-A15)	Atomic and Molecular Physics	4	4	70	30	100
24PHY0603T	Discipline Specific Course (DSC-A16)	Nuclear and Particle Physics	4	4	70	30	100
24PHY0604T	Discipline Specific Course (DSC-A17)	Solid State Physics-II (Theory)	2	2	35	15	50
24PHY0604P		Solid State Physics-II (Practical)	2	4	35	15	50
24VOC0628P	Vocational (VOC)	Instrumentation -III Lab	4	8	70	30	100
			20	26	350	150	500

Note:

i. Students will be awarded 3 years UG degree in the relevant major Discipline/subject upon securing 136 credits.

ii. The Discipline specific course (DSC-A17) is divided into theory and practical parts of 2 credits each i.e., codes 24PHY0604T and 24PHY0604P. Students are separately assessed in these papers and are separately required to obtain minimum pass marks.

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IIIrd Semester

24PHY0301T (DSC-A3): ELECTRICITY AND MAGNETISM

Marks (Theory) : 70 **Credits :4 (60 Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The course on Electricity and Magnetism deals with Coulomb's law, Electric field, potential formulation of electrostatic, Capacitors, Magnetism and magnetic materials along with the applications of these concepts	**Course Outcome:** The student will be able to understand Gauss-divergence theorem, Stokes theorem in dielectrics, electrical and magnetic properties of materials.

UNIT-I

Electrostatics: Electric field, Electric field lines, Electric flux, Divergence of electrostatic field, Gauss' Law with applications, Conservative nature of Electrostatic Field, Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Electrostatic energy of system of charges, Energy per unit volume in electrostatic field, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor, Laplace's and Poisson equations, Laplace equation in three dimension, The Uniqueness Theorems

UNIT-II

The method of images: Point charge in the presence of grounded conducting sphere, Solution of Laplace equation by separation of variables for Cartesian and spherical coordinates, Multipole expansion of potential due to arbitrary charge distribution.

Dielectric Properties: Dielectric medium, Polarization, Bound charges in a polarized dielectric and their physical interpretation, Electric displacement, Gauss's theorem in dielectrics, Parallel plate capacitor completely filled with dielectric, dielectric constant.

UNIT-III

Magnetism: Lorentz force law, Magnetic forces, Magnetostatics: Biot-Savart's law & its applications (1) straight conductor (2) circular coil (3) solenoid carrying current, Divergence and curl of magnetic field, Ampere's circuital law and it's applications for simple current configurations, Magnetic vector potential.

UNIT-IV

Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity (H), Magnetic Susceptibility and permeability, Relation between B, H, M, Para-, Dia- and Ferromagnetism, B-H curve and hysteresis. **Electrical Circuits:** AC Circuits: Kirchhoff's laws for AC circuits, Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width, Parallel LCR Circuit.

Reference Books:

1. D.J. Griffith, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
2. Electricity and Magnetism, Edward M.Purcell, 1986,McGraw-HillEducation..
3. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
4. University Physics, Ronald Lane Reese, 2003, ThomsonBrooks/Cole.

24PHY0302T (DSC-A4): MATHEMATICAL PHYSICS – I

Marks (Theory) : 70 **Credits : 4 (60 Hrs)**

Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The course covers basics of differential equation, vector calculus, vector algebra, vector differentiation, vector integration, probability and errors. These topics are useful for the mathematical basis of electromagnetism and quantum mechanics courses.	**Course Outcomes:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

UNIT-I

Vector Calculus: Recapitulation of vectors: Properties of vectors under rotations, Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative, Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, De and Laplacian operators, Vector identities.

UNIT-II

Vector Integration: Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Notion of infinitesimal line, Surface and volume elements, Line, surface and volume integrals of Vector fields, Flux of a vector field, Gauss's divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials, Constrained Maximization using Lagrange Multipliers.

UNIT-III

Calculus: Recapitulation: average and instantaneous quantities Intuitive ideas of continuous, differentiable, functions and plotting of curves, Approximation: Taylor and binomial series (statements only).

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor, Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

UNIT-IV

Introduction to probability: Independent random variables, Probability distribution functions; Binomial, Gaussian, and Poisson distributions (with examples), Mean and variance, Dependent events: Conditional Probability, Bayes' Theorem and the idea of hypothesis testing.

Theory of Errors: Systematic and Random Errors, Propagation of Errors, Normal Law of Errors, Standard and Probable Error, Least-squares fit, Error on the slope and intercept of a fitted line.

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier.
2. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
3. Mathematical Physics, H K Das, S Chand

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24PHY0303T (DSC-A5): PHYSICS OF SEMICONDUCTOR DEVICES (THEORY)

Marks (Theory): 35 **Credits: 2 (30 Hrs)**

Marks (Internal Assessment): 15 **Time: 2 hrs**

Note: Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The course enables students to develop an in-depth understanding about the physics of semiconductors through an exposure of various types of semiconductor diodes, transistors, binary number systems and logic gates.	**Course Outcomes:** After completion of this course, students will be able to understand the basics of semiconductor materials, semiconductor diodes, BJT and their characteristics along with applications in various electronic devices. The students will be able to understand binary number systems and logic gates.

UNIT – I

Physics of Semiconductors: The Energy-Band theory of Crystals, Classification of materials, Direct and indirect band gap semiconductors, Intrinsic and extrinsic semiconductors, Donor and Acceptor impurities, Carrier Concentrations; The Fermi Level, Charge densities in semiconductors, Electrical properties of Ge and Si.

Semiconductor Diodes: Open circuit p-n junction, V-I characteristics and their dependence, Ideal Diode. The Diffusion capacitance, Breakdown Diodes, Semiconductor Photodiode, LED, p-n junction as rectifier (half, full and bridge rectifier), Ripples, Filters (capacitor, inductor, and π-filters).

UNIT – II

Bipolar Junction Transistors (BJT): The junction transistor and its current components, I-V characteristics, Transistor as an amplifier, Type of transistors, Common-Base (CB), Common-Emitter (CE), Common-Collector (CC) configuration, characteristics of CE, CB, and CC configurations,

Number System and Codes: Decimal, Binary, Hexadecimal and Octal number systems, base conversions. **Logic Gates and Boolean algebra:** Introduction to Boolean Algebra and Boolean operators: De Morgan's Theorems, Boolean Laws, simplifications of Logic Circuits using Boolean Algebra, Positive and negative logic, Truth Tables of OR, AND, NOT, Universal NOR and NAND gates (DTL, TTL gates).

Reference Books:

1. Semiconductor Physics and Devices: Donald A Neaman and Dhrubes Biswas, 4th Edition, McGraw Hill, India
2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
3. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill, India
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning

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24PHY0303P (DSC-A5): Physics of Semiconductor Devices (Practical)

Marks (External) : 35 **Credits : 2 (60Hrs)**

Marks (Internal Assessment) : 15 **Time : 3 Hrs**

1. ***Each student should perform at-least eight experiments.***
2. ***The students are required to calculate the error involved in a particular experiment.***
3. ***List of experiments may vary.***

List of Experiments:

1. Study of depletion capacitance of diode and its variation with reverse bias.
2. To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables.
3. To study Zener diode as a voltage regulator.
4. To study the frequency response of passive filters (low pass, high pass, band pass, band reject) using passive devices.
5. To study half wave and full wave rectifier.
6. To Study I-V characteristics of PN Junction diode.
7. To Study input and output characteristics of n-p-n Transistor
8. To Study input and output characteristics of p-n-p Transistor
9. To study Voltage Doubler and Trippler circuits.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition ,reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011,Kitab Mahal

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24VOC0328P (VOC): Instrumentation – I Lab

Marks (External) : 70 **Credits : 4 (120Hrs)**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

Note: The paper will be evaluated based on practical along with viva-voce of the students.

Course Objective: The course is based on imparting practical knowledge or hands on training on instruments including RC circuits, e/m ratio and on cathode ray oscilloscope etc.	**Course Outcomes:** After completion of this course, students will be able to understand the basic equipment's used in physics laboratory.

1. *Each student should have training on at-least eight experiments.*
2. *The students are required to calculate the error involved in a particular experiment.*
3. *List of experiments may vary.*

List of Experiments:

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To determine the value of e/m by Bar magnet
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti resonant frequency and (b) Quality factor Q.
7. Determination Wavelength of Ultrasonic Wave.
8. To study the damped oscillations
9. To study Lissajous Figures.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub

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24MDC0311T (MDC3): Basics of MATLAB

Marks (External) : 50 | **Credits : 3(45Hrs)**

Marks (Internal Assessment) : 25 | **Time : 2.5 Hrs**

Note: Paper setter is to set seven questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of 2.5 marks. Rest of six questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt four questions in all of marks 12.5, selecting one from each Unit and a compulsory question 1.

Course Objective	Course Outcomes
Course Objective: The course "Basics of MATLAB" is to provide students with a solid understanding of the MATLAB programming language and its applications. The course aims to equip students with the necessary skills and knowledge to utilize MATLAB as a powerful tool for data analysis, visualization, and algorithm development.	**Course Outcomes:** After completion of this course, students will be able to understand the various MATLAB functions used in simulation and modelling of Physical problems. The students are also able to develop the MATLAB programs for various equations used in their curriculum.

UNIT – I

Introduction to MATLAB, MATLAB environment and interface, Variables, data types, and basic operations, Using MATLAB as a calculator, working with arrays and Matrices, displaying output, and using basic formatting, MATLAB Programming: Writing and executing MATLAB, Control flow statements (if-else, for loops, while loops), Logical Operators and relational operators, working with built-in functions.

UNIT – II

Data Manipulation in MATLAB: Indexing and slicing arrays and matrices, working with vectors and matrices operations, basic input/output operations (reading from/writing to files), Importing and exporting data from various file formats, Data Visualization: plotting 2D graphs using MATLAB, customizing plot appearance (labels, titles, colors, etc.), creating multiple plots and subplots.

UNIT- III

Numerical Computations in MATLAB: Solving linear and ordinary differential equations, Numerical Integration and differentiation, Optimization techniques, Curve fitting and interpolation, MATLAB Applications: solution of equations for simple pendulum, Kepler's law, waves on a string

Reference Books:

1. "MATLAB: A Practical Introduction to Programming and Problem Solving" by Stormy Attaway, Edition, Butterworth Heinemann publication.
2. "Programming in MATLAB" by E V Krishnamurthy and S K Sen, East-West Publication.
3. MATLAB The Language of Technical Computing by The MathWorks, Inc.
4. "Computational Physics using MATLAB", Nicholas J Giordano and Hisao Nakanishi.

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24SEC0312T (SEC3): Programming with Python

Marks (External): 35 | **Credits: 2 (30 Hrs)**

Marks (Internal Assessment): 15 | **Time: 2 hrs**

Note: Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1.

Course Objective: The present course is focused on basic of Python languages for solving physics problems/ Formulae.	**Course Outcomes:** After completion of this course, students will be able to do the Python programming for the basic formulae used in physics.

UNIT - I

Basic Elements of Python: The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables (numeric, character and sequence types) and assignments, mathematical operators. Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability Formatting in the print statement. Control Structures: Conditional operations, if, if-else, if-elif-else, while and for Loops, break and continue, Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules.

UNIT - II

NumPy Fundamentals: Importing Numpy, Difference between List and NumPy array, Adding, removing and sorting elements, creating arrays using ones(), zeros(), random(), arange(), linspace(). Basic array operations (sum, max, min, mean, variance), 2-d and 3-d arrays, matrix operations, reshaping and transposing arrays, savetxt() and loadtxt(), create a Pandas dataframe from an array and then write the data frame to a csv file. Plotting with Matplotlib: matplotlib.pyplot functions, Plotting of functions given in closed form as well as in the form of discrete data and making histograms.

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24SEC0312P: Programming with Python Lab

Credits : 1 (30Hrs)

Time : 3 Hrs

Marks (Internal) : 25

For practical (25 marks), the internal examiner is evaluated the students based on the practical performed in the lab. List of experiments may vary.

List of Programs:

1. Plot the displacement-time and velocity-time graph for the undamped, under damped critically damped and over damped oscillator using matplotlib
2. Use recurrence relation for Legendre polynomials to generate and plot these polynomials for the first few orders using matplotlib.
3. To generate array of N random numbers drawn from a given distribution (uniform, binomial, Poisson and gaussian) and plot them using matplotlib for increasing N to verify the distribution. Verify the central limit theorem.
4. To implement the transformation of physical observables under Galilean, Lorentz and Rotation transformation
5. Least Square fitting: Algorithm for least square fitting and its relation to maximum likelihood for normally distributed data.
6. Make Python function for least square fitting, use it for fitting given data (x,y) and estimate the parameters a, b as well as uncertainties in the parameters for the following cases:

   (a) Linear ($y=ax+b$) (b) Power law ($y=ax^b$) and (c) exponential ($y=ae^x$).

Reference Books:

1. Documentation at the Python home page (https://docs.python.org/3/) and the tutorials there (https://docs.python.org/3/tutorial/).
2. Documentation of NumPy and Matplotlib : https://numpy.org/doc/stable/user/ and https://matplotlib.org/stable/tutorials/
3. Computational Physics, Darren Walker, 1st Edn, Scientific International Pvt. Ltd (2015).
4. Elementary Numerical Analysis, K. E. Atkinson, 3rd Edn, 2007, Wiley India Edition.
5. An Introduction to Computational Physics, T. Pang, Cambridge University Press (2010).
6. Introduction to Numerical Analysis, S. S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

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IVth Semester

24PHY0401T (DSC-A6): ELEMENTS OF MODERN PHYSICS

Marks (Theory): 70 **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The aim of the course is to give students a flavor of developments in physics in the last century by introducing the concepts of quantization, dual nature of matter, basic quantum mechanics and cosmology.	**Course Outcomes:** Course Outcome: Students will be aware of foundations of modern physics, experiments forming basis of quantum mechanics, Atomic structure, wave concepts, uncertainty principle and basic idea of cosmology.

UNIT – I

Introduction to electromagnetic waves and spectra, Spectral Distribution of Blackbody Radiation, Stefan-Boltzmann Law and Wien's Distribution and Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's postulates of black body radiation, Planck's Law of Blackbody Radiation, and its experimental verification. Photoelectric effect, Einstein's explanation, and its experimental verification. Compton scattering, Pair production and annihilation, Bremsstrahlung effect, Cherenkov radiation. X-ray Spectra of atoms and its production, Photons and Gravity.

UNIT – II

Atomic structure: Rutherford scattering, Rutherford's model and its drawbacks, Bohr atomic model; quantization rule, atomic stability, calculation of energy levels for hydrogen like atoms and their spectra, effect of nuclear mass on spectra, Correspondence principle, Franck- Hertz experiment.

Wave properties of matter: De-Broglie wavelength and matter waves; Wave-particle duality, Davison and Germer experiment, wave packets, phase velocity, group velocity and their relations Electron microscope.

Uncertainty principle: Heisenberg's uncertainty principle; Estimating minimum energy of a confined particle using uncertainty principle, Energy-time uncertainty principle. Applications

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UNIT – III

Two slit interference experiment with photons, atoms, and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non- relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Application of Schrodinger equation: particle in a box, finite potential well, tunnel effect and harmonic oscillator.

UNIT – IV

Cosmology: The Expansion of the Universe, The Cosmic Microwave Background Radiation, Dark Matter, The General Theory of Relativity, Tests of General Relativity, Stellar Evolution and Black Holes, Cosmology and General Relativity, The Big Bang Cosmology, The Formation of Nuclei and Atoms, Experimental Cosmology.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Modern Physics, Knneth S.Krane, JOHN WILEY & SONS, INC

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24PHY0402T (DSC-A7): Waves and Optics

Marks (Theory) : 70
Marks (Internal Assessment) : 30

Credits : 4 (60 Hrs)
Time : 3 Hrs

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The course covers basics of several optical phenomena including wave motions; Wave Optics consisting interference, diffraction, and polarization of light.	**Course Outcomes:** After completion of this course, students will be able to understand the wave oscillations, interference, diffraction, and polarization of light wave.

UNIT – I

Simple Harmonic Oscillations: Differential equation of SHM and its solution. Simple pendulum and compound pendulum, Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle, Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats); Superposition of N Collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods.

UNIT – II

Wave Motion: Wave Equation, Solution of wave equation, Particle and Wave Velocities, Intensity of Wave. Transverse Waves: The string as a force oscillator, Velocity of Transverse Vibrations of Stretched Strings, Reflections and transmission of waves on a string at a boundary, Reflections and transmission of Energy. Longitudinal Waves: Velocity of Longitudinal Waves in a Fluid in a Pipe, Newton's Formula for Velocity of Sound, Laplace's Correction, Reflections and transmission of sound waves at a boundary, Reflections and transmission of sound intensity, Energy distribution in sound waves.

UNIT- III

Interference of light waves: Intensity distribution in Young's experiment, concept of spatial and temporal coherence, coherence time and coherence length. Examples of interference by division of amplitude: interference in thin films and wedges, Newton's rings, interference by division of wavefront: Michelson Interferometers, Diffraction: Fraunhoffer and Fresnel diffraction- analytical and graphical solutions for diffraction from Single and multiple slits, Resolution of optical systems, Grating and its applications.

UNIT-IV

Polarization: Different states of polarization, double refraction, Huygens' construction for uniaxial crystals, polaroids and their uses. Production and analysis of plane, circularly and elliptically polarized light by retardation plates and rotary polarization and optical activity, Fresnel's explanation of optical activity: Biquartz and half shade polarimeter.

Reference Books:

1. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
2. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
3. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
4. Optics, Hetch,2008, Pearson
5. Fundamentals of Photonics, SPIE, Opens Source

24PHY0403T (DSC-A8): Electromagnetic Theory

Marks (Theory) : 70 **Credits : 4 (60 Hrs)**
Marks (Internal Assessment) : 30 **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical.

Course Objectives: The course on Electricity and Magnetism deals with the Electromagnetic induction, Maxwell's Equations, Electromagnetic wave propagation, Poynting's Vector and electromagnetic field transformation.	**Course Outcomes:** The student will be able to understand electromagnetic induction and it's applications, Maxwell's equations and generation of electromagnetic fields, wave propagation through vacuum and isotropic dielectric medium

UNIT-I

Motional EMF, Faraday's Law of induction, induced electric field, Lenz's law, Inductance, Self-induction of a single coil, Mutual induction of two coils, Transformers, Energy stored in magnetic field. **Maxwell`s equations:** Maxwell's fixing of Ampere's law, Displacement current, Maxwell's equations in vacuum.

UNIT-II

Maxwell's equations in matter, Boundary Conditions, Continuity equation, Poynting Theorem and Poynting vector, Maxwell Stress tensor, Conservation of Momentum and angular momentum in electromagnetic field, Energy density in electromagnetic field.

UNIT-III

The wave equation, Sinusoidal waves, Wave equations for **E** and **B** fields, Electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Energy and momentum in EM waves, Propagation in linear media, Reflection and transmission at Normal and Oblique incidence, Brewster's angle, Wave guides, TEM waves

UNIT-IV

Scalar and vector potential for electromagnetic fields, Gauge Transformation, Coulomb Gauge, Lorentz Gauge, Electric and magnetic dipole radiation (no derivation needed, discussion of results only), Magnetism as relativistic phenomenon, Transformation of electric and magnetic fields between two inertial frames.

Reference Books:

1. D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

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24PHY0404T (DSC-A9): Basic Instruments in Physics (Theory)

Marks (Theory) : 35 | **Credits : 2 (30 Hrs)**

Marks (Internal Assessment) : 15 | **Time : 2 Hrs**

Note: Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: This course aims to cover the fundamental instruments involved for the measurement in the experimental physics. The focus is on the teaching undergraduate students about direct and indirect methods of accurate measurements of fundamental physical quantities.	**Course Outcomes:** After completion of this course, students will be familiar with the instruments of measurement in the experimental physics.

Unit - I

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance, Specifications of multimeters and their significance.

Digital Multimeter: Block diagram and working of a digital multimeter, working principle of time interval, frequency and period measurements using universal counter/ frequency counter, Time - base stability, Accuracy, and resolution.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity, Principles of voltage measurement (block diagram only), Specifications of an electronic Voltmeter/ Multimeter and their significance.

Unit – II

Cathode Ray Oscilloscope: Block diagram of basic CRO, Construction of CRT, Electron gun, electrostatic focusing and acceleration (qualitative treatment only), Time base operation, synchronization, Front panel controls, Use of CRO for the measurement of voltage (dc and ac), frequency and time-period.

Lasers: Basic concept of stimulated emission, amplification, and population inversion; Main components of lasers: (i) Active Medium (ii) Pumping (iii) Optical Resonator; Einstein's 'A' and 'B' coefficients and their relationship; Working of He-Ne and Ruby lasers.

Reference Books

1. Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
2. Experimental Methods for Engineers, J.P. Holman, McGraw Hill
3. The Physics of Metrology, Alexius J. Hebra, Springer 2010
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. Fundamentals of Photonics, SPIE, Opens Source

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24PHY0404P (DSC-A9): Basic Instruments in Physics (Practical)

Marks (External) : 35 | **Credits : 2 (60Hrs)**

Marks (Internal Assessment) : 15 | **Time : 3 Hrs**

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. Study functioning of Cathode ray oscilloscope.
3. To determine the thickness of a thin wire using a laser Source.
4. To determine the wavelength of laser source using diffraction of single slit.
5. To determine the wavelength of laser source using diffraction of double slits.
6. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
7. Comparing intensity of light sources and verify inverse square law.
8. To determine wavelength of laser using plane diffraction grating.
9. Study the characteristics of Photodiodes
10. To determine the particle size of lycopodium powder.

Referred Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

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24VOC0428P (VOC): Instrumentation-II Lab

Marks (External) : 70 **Credits : 4 (120Hrs)**

Marks (Internal Assessment) : 30 **Time : 6 Hrs**

Note: The paper will be evaluated based on practical along with viva-voce of the students.

1. Each student should perform at-least eight experiments.

2. The students are required to calculate the error involved in a particular experiment.

3. List of experiments may vary.

List of Experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Newton's Rings.
5. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
6. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
7. To determine dispersive power and resolving power of a plane diffraction grating.
8. To find the polarization angle of laser light using polarizer and analyzer.
9. To verify Malus law of polarization
10. Measurement of focal length of Mirrors and Lenses
11. To find the specific rotation coefficient for cane sugar using polarimeter.

Reference Books

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

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Vth Semester

24PHY0501T (DSC-A10): Basic Quantum Mechanics

Marks (Theory) : 70 Credits : 4 (60 Hrs)

Marks (Internal Assessment) : 30 Time : 3 Hrs

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objectives: The course content covers foundations of quantum mechanics, Schrodinger wave equation and applications to one dimensional problems, Hydrogen Atom and time dependent and independent Schrodinger equation	**Course Outcomes:** The students will be equipped with basics of quantum Mechanics, Schrodinger wave equation and its applications.

UNIT -I

Linear Vector Space and Matrix Mechanics: Vector spaces, Hilbert spaces, square integrable functions, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Infinitesimal and Finite Unitary operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Parity operators, Exchange operator, Matrix Mechanics and Wave Mechanics, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators.

UNIT-II

Schrodinger Wave Equation: wave function, Normalization, Probability current density, Expectation values, Eigen values and eigen functions, Time evolution of expectation values, stationary states, Ehrenfest Theorem, Degeneracy and orthogonality, Operator formalism and its algebra, Hermitian operators and their properties, Linearity and Superposition Principles, Matrix representation of an operator, Momentum and energy operators, Commutator, Wave Packets, Application to spread of Gaussian Wave packet, Time dependent Schrodinger equation and dynamical evolution of a quantum state, General solution in terms of linear combinations of stationary states.

UNIT -III

Problems in One- Dimension: Discrete and continuous spectrum, Symmetric Potentials and Parity, Free Particle, Potential Step, Potential Barrier, potential well: 1-d Finite potential well problem, Reflection and transmission (tunnel effect) of wave packet from rectangular potential well, 1-D infinite square well potential, Simple harmonic oscillator: Energy levels and energy eigenfunctions using Frobenius method, Hermite polynomials, ground state, zero point energy.

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UNIT -IV

Quantum theory of Hydrogen atom: Schrodinger equation for H-atom, Separation of variables, Quantum numbers, Electron probability density, Radiative transition, Selection rules, Angular momentum operators and their Commutation relations, Schrodinger equation in spherical symmetric potential, Stern-Gerlach experiment

Identical particles: Symmetric and antisymmetric wave functions, distinguishability of identical particles, the exclusion principle, collisions of identical particles, Spin angular momentum: connection between spin and statistics, Atomic levels of Helium atoms as an example of two electron system.

Reference Books :

1. Quantum Mechanics: J.L. Powell and B. Crasemann
2. Quantum Mechanics, D.J Griffith, Pearson publication
3. Quantum Mechanics, A. Ghatak&Loknathan, Mackmilan India Ltd.
4. Quantum Physics ,S.Gasiorowicz , Wiley

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24PHY0502T (DSC-A11): MATHEMATICAL PHYSICS-II

Marks (Theory) : 70 — **Credits : 4 (60 Hrs)**

Marks (Internal Assessment) : 30 — **Time : 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1.

Course Objective: The present course provides an introduction to the Fourier series for periodic functions and their applications. It also develops an understanding of Special mathematical functions required for advanced physics problems.	**Course Outcomes:** After completing this course, students would be able to deal with mathematics that appears in other papers such as Classical Mechanics, Quantum Mechanics, Nuclear Physics, Condensed Matter Physics, etc.

UNIT – I

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

Some Special Integrals: Beta and Gamma Functions and its Relation, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

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

UNIT – II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations, Legendre, Bessel, Hermite and Laguerre Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality, Simple recurrence relations, Expansion of function in a series of Legendre Polynomials.

Bessel Functions of the First Kind: Generating Function, simple recurrence relations, Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality.

UNIT-III

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region.

Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals

UNIT – IV

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

Reference Books:

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

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24PHY0503T (DSC-A12): SOLID STATE PHYSICS-I (THEORY)

Marks (Theory): 35 | **Credits: 2 (30 Hrs)**

Marks (Internal Assessment): 15 | **Time: 2 Hrs**

Note: Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The aim of the course is to familiarize the students with the concepts of Crystal structure, reciprocal lattice, and structure of solids.	**Course Outcomes:** After completion of this course, students will be able to understand about the crystal structure formation and reciprocal lattice.

UNIT – I

Crystal Structure: Introduction to Crystalline, amorphous solids, Crystal lattice and Translation Vectors, Unit cell and basis, Primitive and non-primitive lattices, Symmetry operations, Point groups and space groups, Bravais lattices in 2D and 3D, Lattice planes, Miller Indices, Interplanner spacing, Crystal structures: sc, bcc, fcc and hcp, Examples: NaCl, CsCl, Diamond and ZnS structure.

UNIT – II

Reciprocal lattice: Bragg's law, Fourier analysis of electron density, reciprocal lattice, Diffraction condition in reciprocal space, Laue's equations, Ewald construction, Brillioun zones and Weigner Seitz cell concepts, Brillioun zones construction, Reciprocal lattice (sc, bcc, fcc), Fourier analysis of basis, Atomic scattering factors, Geometrical structure factor, X-ray diffraction method: Laue, Rotating and powder crystal methods.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
3. Neil W Ashcroft and N David Mermin, Solid State Physics, Holt Saunders International Edn, 1976.
4. BD Cullity, Introduction to Magnetic Materials, Addison-Wesley, 1972.
5. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

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24PHY0503P (DSC-A12): SOLID STATE PHYSICS-I (PRACTICAL)

Marks (External) : 35 | **Credits : 2 (60Hrs)**

Marks (Internal Assessment) : 15 | **Time : 3 Hrs**

1. *Each student should perform at-least eight experiments.*
2. *The students are required to calculate the error involved in a particular experiment.*
3. *List of experiments may vary.*

List of Experiments:

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To measure the Dielectric Constant of different specimen.
4. To draw the B-H curve of Fe using Solenoid & determine energy loss from Hysteresis.
5. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 °C) and to determine its band gap.
6. Measurement of Planck's constant using black body radiation and photo-detector
7. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
8. To determine the Planck's constant using LEDs of at least 4 different colours.
9. Study of Fourier series.
10. Study of Boltzmann Constant

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24PHY0504T (DSC-A13): ANALOG SYSTEMS (THEORY)

Marks (Theory): 35 **Credits: 2 (30 Hrs)**

Marks (Internal Assessment): 15 **Time : 2 Hrs**

Note: Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objectives: To introduce students to fundamentals of circuit designs, Amplifiers, Oscillators, Hybrid parameters.	Course Outcomes: After completion of this course, students will be able to understand the basics of network theorems, amplifiers, oscillators, h-parameters.

UNIT-I

Ideal constant-voltage and constant-current Sources, Kirchhoff's Current Law & Kirchhoff's Voltage Law, Mesh & Node Analysis, Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem, Applications to dc circuits.

Concept of feedback in amplifier, Type of feedback, small signal amplifiers, Analysis of stage amplifier by Graphical and Equivalent Circuit methods, Frequency response of RC- coupled amplifiers, Classification of amplifiers (NPN or PNP), Classification of oscillators, LC and RC oscillators.

UNIT-II

Graphical Analysis of the CE Configuration, Two-port Devices and the Hybrid Model, Transistor Hybrid Model, Conversion Formulas for the Parameters of the Three Transistor Configurations, Analysis of a Transistor Amplifier Circuit Using h Parameters.

The Emitter Follower, Comparison of Transistor Amplifier Configurations, Linear Analysis of a Transistor Circuit, Cascading Transistor Amplifiers, Simplified Common-emitter Hybrid Model, The Common-emitter Amplifier with an Emitter Resistance.

Reference Books:

1. Basic Electronics and Linear Circuits, N. N. Bhargava et. al., 2nd Edition, McGraw Hill Education, India
2. A text book in Electrical Technology, B. L. Theraja, S. Chand & Co.
3. Circuit and Networks, 2nd Edition, A Sudhakar and Shyammohan S Palli, Tata McGraw-Hill
4. Integrated electronics by Jacob Millman, Christos Halkias, Chetan Parikh, McGraw Hill Education, India

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24PHY0504P (DSC-A13): ANALOG SYSTEMS (PRACTICAL)

Marks (External) : 35

Credits : 2 (60Hrs)

Marks (Internal Assessment) : 15

Time : 3 Hrs

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Verify Thevenin and Norton Network Theorem
2. To verify the Superposition, and Maximum power transfer theorems.
3. Study frequency response of R-C Coupled Amplifier
4. Study characteristics of a Push-Pull Amplifier
5. Study a LC/RC Oscillator using transistors
6. Study of Analog Communication System.
7. Study of NPN transistor as Amplifier.
8. Study of PNP transistor as Amplifier.
9. Study of Tunnel Diode characteristics.
10. Study of h-parameter of a transistor.

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24PHY0505I: Internship

Credits: 4

Marks (Internal): 100

Note: The internship (120 hrs. (minimum 4 weeks duration)) done by a student either inside or outside the institute are assessed by at least two senior teachers of the parent department in the form of presentation and a report submitted by the student which is signed by the internship supervisor of the student. Marks will be awarded by the committee out of 100 marks on the basis of report and viva-voce examination.

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VI^th^ Semester

24PHY0601T (DSC-A8): Classical and Statistical Mechanics

Marks (Theory): 70 **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The objective of the course is to provide a basic knowledge of constraints, planetary motion, Langrange's formulation of classical system of particles. The course also includes the basics of classical and quantum statistical.	*Course Outcomes*: After completion of this course, students will be able to understand the basics of classical and statistical mechanics.

UNIT – I

Two-body central force problem and Lagrangian Dynamics: Constraints & their classification, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Simple applications of the Lagrangian formulation, Velocity-dependent potentials and the dissipation function, Hamilton's principle, Derivation of Lagrange's equations from Hamilton's principle, Cyclic coordinates, Conservation theorems and symmetry properties. Two –body central force problem: Reduction to the equivalent one-body problem, Equations of motion and first integrals, Equivalent 1-D problem, and classification of orbits.

UNIT –II

Rigid Bodies- Kinematics and Dynamics: Independent coordinates of the rigid bodies, orthogonal transformations, Euler angles and Euler's theorem, Infinitesimal rotation, rate of change of a vector, Coriolis force, angular theorem, infinitesimal rotation, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of asymmetrical top.

UNIT- III

Introduction to Statistical Physics: Laws of Thermodynamics, Entropy and Disorder, Statistical Definition of Entropy, Macroscopic and Microscopic Systems, Events (dependent, independent and mutually exclusive), statistical Probability, a-priori probability, probability theorems, Tossing of Coins, Permutations and Combinations, Distribution of N distinguishable and indistinguishable particles in boxes, Macro and Micro states, Thermodynamic potentials and Thermodynamic equilibriums, phase space, Liouville's Theorem, Density Matrix, Fluctuations.

UNIT-IV

Classical and Quantum Statistics: Maxwell- Boltzmann Statistics applied to an ideal gas, M.B. velocity distribution law, Thermodynamical quantities, ideal Boltzmann gas, Monoatomic and Diatomic ideal gases, Bose- Einstein energy distribution law, B-E Gas, Degeneracy and B.E. Condensation, Fermi- Dirac energy distribution Law,

F.D. Gas and Degeneracy, Fermi Energy and Fermi Temperature, Zero-point Energy, Zero-point Pressure and average speed (at 0K) of electron gas, Specific heat Anomaly of metals and its solution, M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three Statistics.

Reference Books:

1. Classical Mechanics, 3rd ed.,2002 by H.Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics of particles and rigid bodies by K. C. Gupta New Age International 2008

24PHY0602T (DSC-A15): ATOMIC AND MOLECULAR PHYSICS

Marks (Theory): 70

Credits : 4(60 Hrs)

Marks (Internal Assessment): 30

Time : 3 Hrs

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objective: The present course is designed to provide the basic information on introduction to atomic spectra for one electron and multi electron systems. In addition, vibration, rotational and electronic spectra of molecules will be taught.	**Course Outcomes:** After completion of this course, students will be familiar with the atomic spectra for one and two electrons system, diatomic molecules and rotational and Vibrational spectra.

UNIT – I

Introduction to atomic spectra, one electron atoms: Bohr model of hydrogen atom, Somerfield modification of Bohr model for hydrogen atom, Quantum theory of hydrogen atoms, Quantum numbers of hydrogen atom wave function, Atomic orbitals, Vector representation of momenta and vector coupling approximations, Electron Spin, Spin orbit interaction, Vector model for atoms, Pauli Exclusion Principle, Angular momentum and magnetic moments of atoms, Coupling of angular momenta, Term symbol and derivation from electronic configuration.

UNIT –II

Two electrons systems: L-S and J-J coupling, Interaction energy in L-S and J-J coupling (sp, pd configuration), Lande interval rule, Pauli principal, selection rules, Normal and Anomalous Zeeman effects, Paschen back effect, Stark effect.

Intensities of spectral lines, General selection rule, Hyperfine structure of spectral lines: Isotope effect and effect of nuclear spin.

UNIT-III

Diatomic molecules and their rotational spectra: Types of molecules, Diatomic linear symmetric top, Asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as rigid rotator, energy levels, Rotational spectra of diatomic molecules as non-rigid rotator, Raman Effect, Classical and quantum theory of Raman spectra, Rotational Raman spectrum. Comparison of observed rotational and Raman spectra with the observed spectra based on rigid and non-rigid rotators.

UNIT –IV

Diatomic molecules and their vibrational spectra: Vibrational energy of diatomic molecules, Molecules as Harmonic Oscillator, Energy levels, vibrational and Raman spectra, Molecules as Anharmonic Oscillator, Energy levels, vibrational and Raman spectra. Comparison of observed vibrational and Raman spectra with the observed spectra based on harmonic and anharmonic oscillators.

Reference Books:

1. Introduction to atomic spectra by H.E. White, McGRAW Hill Book.
2. Atomic & Molecular spectra by Raj Kumar, KedarNath Ram Nath, Meerut
3. Spectra of diatomic molecules by G. Herzberg.

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24PHY0603T (DSC-A16): Nuclear and Particle Physics

Marks (Theory): 70 | **Credits: 4 (60 Hrs)**

Marks (Internal Assessment): 30 | **Time: 3 Hrs**

Note: Paper setter is to set nine questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of seven short answer type questions, each of two marks. Rest of Eight questions is to be set uniformly selecting two questions from each Unit. A student is required to attempt five questions in all selecting one from each Unit and a compulsory question 1. The question paper shall contain 20% numerical problems.

Course Objectives: The objective of the course on Nuclear & Particle Physics is to familiarize the students to the basic concepts like properties of nuclei, radioactive decays, nuclear shapes, some elementary nuclear models, nuclear forces, interaction of energetic particles with matter along with the basic classification of elementary particles.	**Course Outcomes:** After taking the course, students should be able to understand some of the concepts, laws and framework of elementary models in nuclear physics together with basic classification of elementary particles

UNIT-I

Basic Properties of Nuclei: Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear mass, size, spin, parity, magnetic dipole moment, quadruple moment (shape concept) and binding energy, Systematic of nuclear binding energy per nucleon curve.

Radioactivity: Law of Radioactive Decay, Half-life and mean life time, Radioactive Series, α-decay: Range of α-particles, Geiger-Nuttal law and α-particle Spectra, Gamow Theory of Alpha Decay, β- decay, Energy Spectra and Neutrino Hypothesis, γ-decay, Origin of γ-rays, Nuclear Isomerism, and Internal Conversion.

UNIT- II

Nuclear Models and Nuclear Forces: Similarity between nuclear matter and liquid drop, Liquid drop model, Semi-classical mass formula, Limitations of liquid drop model, Experimental signature of shell structure in nuclei, Magic number, Nuclear Shell Model (qualitative only) and its applications, Yukawa's Hypothesis, Meson Theory of nuclear forces.

UNIT- III

Radiation Interaction: Interaction of energetic heavy charged particles (proton, Alpha particles etc.); Energy loss of heavy charged particle (Bethe formula, no derivation), Range of alpha particles, Interaction of light charged particle (Beta-particle), Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect), Absorption of Gamma rays (Mass attenuation coefficient), Interaction of neutrons.

Nuclear Radiation Detectors: Gas filled counters; Ionization chamber, proportional counter, G.M. Counter, Scintillation detector, semiconductor detector and neutron detectors

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UNIT- IV

Particle Physics: Concept of anti-particle, Discoveries of neutron, positron, pion and muon (qualitative discussion), Particle interactions; Four fundamental interactions and their comparison, Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, Concept of quark model, Color quantum number.

References:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Nuclear Physics by S. B. Patel, New Age publication
3. Introduction to the physics of nuclei and particles by R.A. Dunlap (Singapore: Thomson Asia, 2004).
4. Nuclear physics by Irving Kaplan. (Oxford & IBH, 1962).
5. Introductory nuclear physics by Kenneth S. Krane (John Wiley & Sons, 1988).

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24PHY0604T (DSC-A17): SOLID STATE PHYSICS-II (THEORY)

Marks (Theory): 35 | **Credits: 2 (30 Hrs)**

Marks (Internal Assessment): 15 | **Time: 3 Hrs**

Note: *Paper setter is to set five questions in all. Question no. 1 (compulsory based on the entire syllabus) will consist of five short answer type questions, each of three marks. Rest of four questions are to be set uniformly selecting two questions from each Unit. A student is required to attempt three questions in all selecting one from each Unit consisting of 10 marks each and a compulsory question 1. The question paper shall contain 20% numerical problems.*

Course Objective: The aim of the course is to familiarize the students with the concepts of Crystal structure, bonding in solids, elastic constants, and magnetic properties of solids.	**Course Outcomes:** After completion of this course, students will be able to understand the bonding in solids, elastic constants, and magnetic properties of solids.

UNIT – I

Bonding in solids: Force between atoms, Cohesion of atoms and cohesive energy, Crystal of inert gases, Van der Waal interaction, Repulsive interaction, Equilibrium lattice constants, Ionic crystals, Lattice energy of ionic crystal, Madelung constant of ionic crystal, Covalent crystals, Metals, Hydrogen Bonds, Atomic radii.

Elastic constants: Elastic strains, Stress components, Stiffness constants for cubic crystals, Elastic energy density, Bulk Modulus and Compressibility, Elastic waves.

UNIT – II

Magnetic Properties: Origin of magnetism, Types of magnetism, Dia-, Para-, Ferri-, Ferro and anti-ferromagnetic materials, Langevin's Classical and quantum Theory of Dia– and Paramagnetic, Curie's law, Weiss's Theory of Ferromagnetism, Exchange interactions, Spin Hamiltonian, and the Heisenberg model; Spin waves- magnons, Ferromagnetic domains: Magnetization curve, Bloch wall, Origin of domains.

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Neil W Ashcroft and N David Mermin, Solid State Physics, Holt Saunders International Edn, 1976.
3. BD Cullity, Introduction to Magnetic Materials, Addison-Wesley, 1972.
4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

24PHY0604P (DSC-A17): SOLID STATE PHYSICS-II (PRACTICAL)

Marks (External) : 35

Marks (Internal Assessment) : 15

Credits : 2 (60Hrs)

Time : 3 Hrs

1. Each student should perform at-least eight experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. List of experiments may vary.

List of Experiments:

1. Study of Crystal Oscillator
2. Magnetic field measurement using Helmotz coil.
3. Study of Solid-State Power Supply.
4. Characteristic of solar cell
5. Study of dielectric constant and determination of Curie temp of Ferroelectric Ceramics.
6. To study modulation and demodulation (Amplitude and frequency).
7. To study and perform Pulse Amplitude Modulation and Demodulation.
8. To study and perform Pulse Width Modulation and Demodulation.
9. To study and perform Pulse Position Modulation and Demodulation.

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