SCHOOL OF STUDIES IN PHYSICS

VIKRAM UNIVERSITY, UJJAIN

Faculty of Science

M. Sc. (Physics)

(As per Common Ordinance No. 14)

Scheme of Examination and Courses of

Studies Including Recommended Books

for the Examination of year

2018-19 and onwards

LOCF

Based on Choice Based Credit System (CBCS)

INTRODUCTION

M.Sc. Physics is a two years (four semesters) Post Graduate level course intended to prepare competent youth to develop specialized knowledge and skills to engage themselves in scientific activities. This learning outcomes-based curriculum framework (LOCF) for the postgraduate programs in Physics is intended to provide a broad framework within which both the postgraduate programs in Physics help to create an academic base that responds to the need of the students to understand the basics of Physics and its ever evolving nature of applications in explaining all the observed natural phenomenon as well as predicting the future applications to the new phenomenon with a global perspective. This course is designed and formulated in order to acquire and maintain standards of achievement in terms of knowledge, understanding and skills in Physics and their applications to the natural phenomenon as well as the development of scientific attitudes and values appropriate for rational reasoning, critical thinking and developing skills for problem solving and initiating research which are competitive globally. The multicultural fabric of our nation requires that the institutions involved in implementing this curriculum framework also work hard towards providing an environment to create, develop and inculcate rational, ethical and moral attitudes and values to help the creation of knowledge society needed for scientific advancement of our nation.

After successful completion of the course the learner will also be competent and confident to capture and join various job opportunities at public and private sectors . Besides planning career in area of research and development, learners can also prepare themselves in teaching and Academics.

OBJECTIVES OF THE PROGRAMME

The overarching aims of M. Sc. Physics are to:

- ✓ To provide a broad foundation in Physics that stresses scientific reasoning and analytical problem solving with nature's perspective.
- ✓ To make the Department a growing centre of excellence in teaching, cutting-edge research, curriculum development and popularizing Physics.
- ✓ To provide the students with the skills required to succeed as competent professionals in industry or Physics and its related professions.

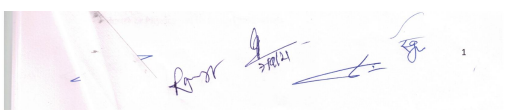
- ✓ Provide students with learning experiences that develop broad knowledge and understanding of key concepts of Physics and equip them with advanced knowledge and understanding for analyzing and performing the tasks concerning scientific affairs.
- ✓ Develop students' ability to apply the acquired knowledge and skills to the solution of specific theoretical and applied problems in Physics.
- ✓ Develop abilities in students to come up with innovative prescriptions/solutions for the benefit of society, by diligence, leadership, team work and lifelong learning.
- ✓ Provide students with skills that enable them to get employment in public, private, non governmental sectors; pursue higher studies; participate in quality research assignments.

PROGRAM LEARNING OUTCOMES (PLO)

The learning outcome based curriculum framework in Physics should also allow for the flexibility and innovation in the program design of the PG education, and its syllabi development, teaching learning process and the assessment procedures of the learning outcomes. The process of learning is defined by the following steps which should form the basis of final assessment of the achievement at the end of the program:-

1. The accumulation of facts of nature and the ability to link the facts to observe and discover the laws of nature i.e. develop an understanding and knowledge of the Physics.
2. The ability to use this knowledge to analyze new situations and learn skills and tools like mathematics, engineering and technology to find the solution, interpret the results and make predictions for the future developments.
3. The ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the physical problems in nature and to create new skills and tools for their possible solutions.
4. Competency to respond on contemporary needs of Research and development and equip them with necessary knowledge, wisdom and skills relevant for local, national and international governance.

The conceptualization and formulation of the learning outcomes for M.Sc. Physics program is aimed to achieve all the above.



PROGRAMME SPECIFIC OUTCOMES (PSO)

The program specific outcomes of the M.Sc. Physics program are as under –

1. A systematic and coherent understanding of basic physics including the concepts, theories and relevant experimental techniques in the domains of Mechanics, Thermal Physics, Electricity and Magnetism, Modern Physics, Optics, Mathematical Physics and of the specialized field like Nuclear and Particle Physics, Quantum Physics, Embedded Systems, etc. in their choice of Discipline Specific Elective course.

2. A wide ranging and comprehensive experience in physics laboratory methods in experiments related to mechanics, optics, thermal physics, electricity, magnetism, digital electronics, solid state physics and modern physics. Students acquire the ability for systematic observations, use of scientific research instruments, analysis of observational data, making suitable error estimates and scientific report writing.

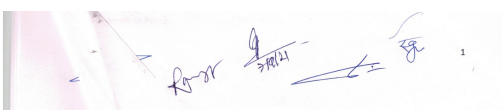
3. Ability to relate their understanding of physics to other subjects like Mathematics, Chemistry, Computer Science or Electronics, which are part of their curriculum, and hence orient their knowledge and work towards multi-disciplinary/inter-disciplinary contexts and problems.

4. Procedural knowledge that creates different types of professionals related to different areas of study in Physics and multi/interdisciplinary domains, including research and development, teaching, technology professions, and government and public service.

5. Skills in areas related to specializations, relating the subfields and current developments in the field of Physics.

PROGRAMME SCHEME

Based on **'The UGC guidelines on adaption of Choice Based Credit System (C.B.C.S.)'**, the Vikram University is going to introduce Credit Based Semester System (C.B.S.S.) at the M.Sc. (Physics) level from the Academic Session 2016-17. The UGC has also given the option to modify the course contents according to specific needs. After a thorough review of this



Curriculum of Choice Based Credit System by the members of Board of studies of Physics, it has felt necessary to reorganize the course content, number of papers and their order so as to give it a more systematic and balanced look. Despite the changes, basic common framework and spirit of the Curriculum i.e. to enhance the quality and standard of education as proposed by the UGC, remains unchanged.

The School of Studies in Physics, Vikram University, Ujjain has adapted Choice Based Credit System (C.B.C.S.) in M.Sc., Physics. This is 04 semesters (each semester of ~ 90 days) academic program (02 years duration). There are 120 total credits in all 4 semesters (in I Semester-**30**, II Semester-**30**, III Semester-**30**, IV Semester-**30, Total-120**). Students have to earn these credit points.

Out of these Total 120 Credits, 40 Credits must be accrued from Core papers, Core Elective Centric (CEC), Elective Generic (GE), Practical &Viva voce of papers of each semester, Soft Skills development, An Equivalent MOOC and enhancement (Seminars-4), Minor Project / Industrial Training Work and Viva voce on the Project work. From these Total 120 Credits, the Credits for each subhead are as following:-

Table -1: Papers and Credits

S. No.	Paper/ Activity	Number of Papers	Credits	Total Credits
1	Core -Papers	14	04	56
2	Core Elective Centric (CEC)	02	04	08
3	Elective Generic (EG) / An Equivalent MOOC	03	04	12
4	Practical & Viva voce	04	06	24
6	Minor Project / Industrial Training	01	04	04
7	Comprehensive Viva voce	04	04	16
TOTAL				**120**

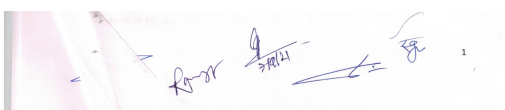
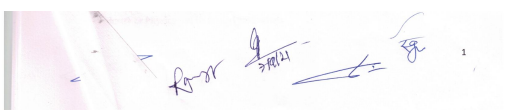


Table-2: The Core and other Papers

S. No.	**Core –Papers** **(56 Credits)**	**Core Elective Centric (CEC Choice based- any one) (4 Credit)**	**Elective Generic** **(EG Choice based- anyone)** **(4 Credit)**	**Practical, Comprehensive Viva voce** **(6x4+4x4=40 Credit)**	Skill Development **(4 Credits)**
1	Mathematical Physics	Advance Electronics (Digital Electronics)	Entrepreneurship Development	Laboratory Course I (Electrical) 6 Credit	Project Work in an institution or in the UTD 4 Credit Minor Working Project Model (Internal)
2	Statistical Mechanics	Advance Solid State Physics	Communication Skills	Laboratory Course II (General) 6 Credit	
3	Quantum Mechanics-I	Plasma Physics	Personality Development	Laboratory Course III (General) 6 Credit	
4	Electrodynamics and Plasma Physics	Spectroscopy		Laboratory Course IV (Electronics) 6 Credit	
5	Atomic and Molecular Physics	Microprocessor		Comprehensive Viva voce (each sem) 6 Credit	



6	Classical Mechanics	Laser & Applications			
7	Quantum Mechanics-II	Fiber Optics and Integrated Optics			
8	Electronics Devices	Physics of Nano-materials			
9	Condensed Matter Physics-I				
10	Nuclear and Particle Physics-I				
11	Advanced Quantum Mechanics-I				
12	Condensed Matter Physics-II				
13	Nuclear and Particle Physics-II				
14	Advanced Quantum Mechanics-II				
Total Credits – 120					

***CEC papers are available for the students of other departments/faculties.**

M.Sc. Physics

Semester-I (CBCS)

Course Code	Course Title	Credits	Equivalent Marks allotted (End Semester Examination + CCE)	Passing Marks (As per Item No. 10.4 of ordinance 14)
PHY-101 Core	Mathematical Physics	4	100(60+40)	35
PHY-102 Core	Statistical Mechanics	4	100(60+40)	35
PHY-103 Core	Quantum Mechanics-I	4	100(60+40)	35
PHY-104 Core	Electrodynamics and Plasma Physics	4	100(60+40)	35
PHY-105 Elective Generic	Entrepreneurship Development / An Equivalent MOOC	4	100(60+40)	35
PHY-106	Laboratory Course I (Electrical)	6	100	35
PHY-107	Comprehensive Viva voce	4	100	35
	Total Credits/Marks	**30**	**700**	

Semester-II (CBCS)

Course Code	Course Title	Credits	Equivalent Marks allotted (End Semester Examination + CCE)	Passing Marks (As per Item No. 10.4 of ordinance 14)
PHY-201 Core	Atomic and Molecular Physics	4	100(60+40)	35
PHY-202 Core	Classical Mechanics	4	100(60+40)	35
PHY-203 Core	Quantum Mechanics-II	4	100(60+40)	35
PHY-204 Core	Electronics Devices	4	100(60+40)	35
PHY-205 Elective Generic	Communication Skills / An Equivalent MOOC	4	100(60+40)	35
PHY-206	Laboratory Course II (Non-Electrical)	6	100	35
PHY-207	Comprehensive Viva voce	4	100	35
	Total Credits/Marks	**30**	**700**	

Semester-III (CBCS)

Course Code	Course Title	Credits	Equivalent Marks allotted (End Semester Examination + CCE)	Passing Marks (As per Item No. 10.4 of ordinance 14)
PHY-301 Core	Condensed Matter Physics-I	4	100(60+40)	35
PHY-302 Core	Nuclear and Particle Physics-I	4	100(60+40)	35
PHY-303 Core	Advanced Quantum Mechanics-I	4	100(60+40)	35
PHY-304 Core Elective Centric (any one)	B. Advance Electronics (Digital Electronics) C. Advance Solid State Physics D. Plasma Physics E. Spectroscopy	4	100(60+40)	35
PHY-305 Elective Generic	Personality Development / An Equivalent MOOC	4	100(60+40)	35
PHY-306	Laboratory Course III (General)	6	100	35
PHY-307	Comprehensive Viva voce	4	100	35
	Total Credits/Marks	**30**	**700**	

Semester-IV (CBCS)

Course Code	Course Title	Credits	Equivalent Marks allotted (End Semester Examination + CCE)	Passing Marks (As per Item No. 10.4 of ordinance 14)
PHY-401 Core	Condensed Matter Physics-II	4	100(60+40)	35
PHY-402 Core	Nuclear and Particle Physics-II	4	100(60+40)	35
PHY-403 Core	Advanced Quantum Mechanics-II	4	100(60+40)	35
PHY-404 Core Elective Centric (any one)	A. Microprocessor B. Laser & Application C. Fiber Optics and Integrated Optics D. Physics of Nano-materials	4	100(60+40)	35
PHY-405 Skill Development	Minor Project / Industrial Training	4	100 (60 model+40 Presentation)	35
PHY-406	Laboratory Course IV (Electronics)	6	100	35
PHY-407	Comprehensive Viva voce	4	100	35
	Total Credits/Marks	**30**	**700**	

COURSE LEARNING OUTCOME (CLO) AND COURSE CURRICULUM

Semester - I

Core Paper 1:
PHY – 101 [Mathematical Physics]

CLO- Students will be able

1. To apply and analyze the various vector and matrix operations for solving physical problems.
2. To demonstrate and utilize the concepts of Fourier series, Fourier transforms and Laplace Transforms.
3. To apply partial differential equations and special functions for solving mathematical problems.
4. To solve problems in various branches of Physics as well as engineering.

Unit-I

Vector Spaces and Matrices: Vector Spaces; Base, Dimension, Inner product space, Linear transformations, Matrices; Inverse, Orthogonal and Unitary matrices, Independent elements of a matrix, Eigen values and eigenvectors, Diagonalisation of a matrix, Complete Orthogonal sets of functions.

Unit-II

Differential Equations and Special Functions: Second order linear Ordinary Differential Equations with variable coefficients; Solution by series expansion; Legendre, Bessel, Hermite and Lagurre equations; Generating functions; Recursion relations, Physical Applications: Solving one dimensional harmonic oscillator; Schrödinger equation and Hydrogen atom, Schrödinger equation with Lagurre equation.

Unit-III

Integral Transforms: Integral transform; Laplace transform; Inverse LT by partial fractions; Solution of initial value problems by LT.

Unit-IV

Fourier Series and Fourier Transform: Fourier series; FS of arbitrary period; Half-wave expansions; Partial sums; Fourier integral and transforms; FT of delta function; Solution of time dependent problems by FT.

Text and Reference Books

1. G. Arfken: Mathematical Methods for Physics (Academic Press, INC. (London) Ltd.)
2. A. W. Joshi: Matrices and Tensors in Physics (Wiley Eastern Ltd, New Delhi)
3. E. Kreyszig: Advanced Engineering Mathematics (Wiley Eastern Ltd, New Delhi)
4. E. D. Rainville: Special Functions (The Macmillan Company, NewYork)
5. W. W. Bell: Special Functions (Dover Publication Inc.)
6. K.F. Reily, M.P. Hobson and S.J. Bence: Mathematical Methods for Physicists andEngineers (Cambridge University Press)
7. Mary L Boas: Mathematics for Physicists (John Wiley & Sons)

Semester - I

Core Paper 2:
PHY – 102 [Statistical Mechanics]

CLO- Students will be able to

1. Develop the concept of phase space to define and formulate the dynamical systems.
2. Identify the dynamical systems in Biology, Chemistry, Economics and computing and
3. Learn to simulate onset of chaos (Fluctuations) in simple dynamical systems in various conditions.
4. Learn to solve the basic equations to explain the basic properties of fluids like thermal Conductivity, viscosity, mass diffusivity etc.
5. Demonstrate some simple examples of fluid flow as described in the syllabus.

Unit-I

Foundations of Statistical Mechanics; Specification of states of a system, Statistical interpretation of the basic thermodynamic variables, Classical ideal gas, Entropy of mixing and Gibb's paradox.

Unit-II

Microcanonical ensembles, Phase space, Trajectories and density of states, Liouville's theorem,Canonical and Grand canonical ensembles, Partition function, Calculation of statistical quantities:Energy and Density fluctuations.

Unit-III

Density matrix, Statistics of ensembles, Statistics of indistinguishable particles; Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics, Properties of ideal Bose and Fermi gases,Bose-Einstein condensation.

Unit-IV

Correlation of space-time dependent fluctuations, Fluctuations and transport phenomena; Brownian motion; Langevin theory, Fluctuation dissipation theorem, The Fokker-Plank equation.

Text and Reference Books

1. F. Reif: Fundamentals of Statistical and Thermal Physics (Mcgraw-Hill Series)
2. K. Huang: Statistical Mechanics (Wiley eastern Ltd.)
3. R. K. Patharia: Statistical Mechanics (Pergamon Press)
4. R. Kubo: Statistical Mechanics (North-Holland Publishing Company, Amsterdam Landon)
5. Landau and Lifshitz: Statistical Physics (Pergamon Press, Oxford)
6. B.B. Laud: Fundamentals of Statistical Mechanics (New Age International Publisher)

Semester - I

Core Paper 3:
PHY – 103 [Quantum Mechanics-I]

CLO- Students will be able to understand

1. Various experiments establishing quantum physics and their interpretation.
2. Wave-particle duality, uncertainty relation and their implications.
3. Schrodinger equation and its simple applications in one dimensional potential problems of scattering.
4. Comprehension of the failure of classical physics and need for quantum physics.
5. To grasp the basic foundation of various experiments establishing the quantum physics by doing the experiments in laboratory and interpreting them.

6. How to model a given problem such as hydrogen, particle in a box etc. atom etc using wave function, operators and solve them.
7. Different Quantum Systems & formulate the basic theoretical problems in one, two and three dimensional physics and solve them.

Unit-I

Inadequacy of classical mechanics, Schrödinger equation, Continuity equation, Ehrenfest theorem, Admissible wave function, Stationary states. One-dimensional problems, Wells and barriers, Harmonic oscillator by Schrödinger and by operator method.

Unit-II

Uncertainty relation of x and p, States with uncertainty product, General formalism of wave mechanics, Commutation relations, Representation of states and dynamical variables, Completeness of eigen functions, Dirac-delta function, Bra and Ket notation, Matrix representation of an operator, Unitary transformation.

Unit-III

Angular momentum in QM, Central force problem, solution of Schrödinger equation for spherically symmetric potentials, Hydrogen atom.

Unit-IV

Time independent or stationary perturbation theory; Non-degenerate case; Applications such as Stark effect.

Text and reference books

1. L I Schiff: Quantum Mechanics (Mcgraw-Hill Book Company)
2. S Gasiorowicz: Quantum Physics (Wiley, New York)
3. J D Powell and B Craseman: Quantum Mechanics (Addison Wesley Publishing Company)
4. A P Messiah: Quantum Mechanics (North - Holland)
5. J J Sakurai: Modern Quantum Mechanics (Pearson Education, INC.)
6. Mathews and Venkatesan: A text book of Quantum Mechanics (Tata McGraw-Hill Publishing Company Ltd.)
7. A Ghatak & S Loknathan: Quantum Mechanics; Theory and Applications (Macmillan IndiaLtd.)

Semester - I

Core Paper 4:
PHY – 104 [Electrodynamics and Plasma Physics]

CLO - Students will be able to

1. Comprehend the role of Maxwell's equation in unifying electricity and magnetism.
2. Learn the implications of Gauge invariance in EM theory in solving the wave equations and develop the skills to actually solve the wave equation in various media.
3. Learn the basic physics associated with the polarization of electromagnetic waves.
4. Learn the fundamentals of plasma and application of wave propagation in magneto plasma; electromagnetic waves propagating parallel and perpendicular to the magnetic field.

Unit-I

(i) Review of four-vector and Lorentz transformations in four-dimensional space; Covariance form and transformation equations for Lorentz condition, electromagnetic potentials, Lorentz force law, Continuity equation, electric and magnetic field equations and Maxwell's field equations.

(ii) Wave equation for vector and scalar potential and solution, Retarded potential and Leinard-Wiechert Potential, Electric and magnetic fields due to a uniformly moving charge.

Unit-II

(i) Reaction force of radiation; Abraham-Lorentz equation of motion.

(ii) Motion of charged particles in electromagnetic field: Uniform E and B fields, Time varying E and B fields.

Unit-III

(i) Elementary concept: Plasma oscillations, Debye shielding, Plasma parameters.

(ii)Hydrodynamical description of plasma: Fundamental equations, Hydromagnetic waves: Magnetosonic and Alfven waves.

Unit-IV

(i) Wave phenomena in magneto plasma: Polarization, Phase velocity, Group velocity, Cut-offs and Resonance for electromagnetic waves propagating parallel and perpendicular to the magnetic field.

(ii) Propagation through ionosphere and magnetosphere.

Text and reference books

1. W. K. H. Panofsky and M. Philips: Classical electricity and magnetism (Addison – Wesley Publishing Company, Inc.,1962).
2. J.D. Jackson: Classical electrodynamics (Berkley, California, III Edition ,2007)
3. J.A. Bittencourt: Fundamentals of Plasma Physics (Springer, III Edition)
4. F.F. Chen: Introduction to Plasma Physics (Plenum Press, III Print)

Semester - I

Soft Skill and Ability Enhancement (Elective Generic)

PHY – 105 [Entrepreneurship Development]

CLO - Students will be able to

1. Prepare the budding entrepreneurs and to provide them seedbeds of entrepreneurship at the entry level by enhancing their entrepreneurial skills.
2. Comprehend the opportunities in Entrepreneur and developing the Process of sensing and accessing the impact of opportunities and threats.
3. Understand the legal requirements for establishing of a new unit-procedure for registering business.
4. Learn the procedure of starting of new venture, product designing/branding, research and development and selection of forms of business organization.

Unit I: Introduction

Entrepreneurship- meaning, nature, importance, specific traits of Entrepreneurs, Role of entrepreneurs in Indian Economy.

Unit II: Analysis of Entrepreneur opportunities

Defining, Objectives, Identification, Process of sensing, accessing the impact of opportunities and threats.

Unit III: Search of Business Idea

Preparing for business plan, legal requirements for establishing of a new unit-procedure for registering business, starting of new venture, product designing/branding, research and development, selection of forms of business organization.

UnitIV: Role of Supportive Organizations

D.I.C and various government policies for the development of entrepreneurship, Government schemes and business assistance; subsidies, Role of banks.

UnitV: Market Assessment

Meaning of market assessment, components and dimensions of market assessment, Questionnaire preparations, survey of local market, visit to industrial unit, business houses, service sector etc. Submission of Survey based report on one successful/ one unsuccessful entrepreneur.

Text and reference books

1. Entrepreneurship Development; Dr. C.B. Gupta
2. Dynamics of Entrepreneurial Development and Management; Vasant Desai
3. Innovation and Entrepreneurship; Peter F. Drucker
4. Entrepreneurship Development; G.A. Kaulgud
5. Entrepreneurship-Need of the Hour; Dr. Vidya Hattangadi
6. Entrepreneurship Development; Dipesh D. Uike

M. Sc. Physics
I Semester
PHY – 106[Laboratory Course –I (Electrical)]

At least 10 practicals of electrical and general electronics background.

M. Sc. I Semester
PHY – [107 Comprehensive Viva voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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M.Sc. Physics (CBCS)

Semester - II

Core Paper 5:
PHY - 201 [Atomic and Molecular Physics]

CLO- Students will be able to

1. Grasp the basic foundation and instrumentation of Raman Spectroscopy
2. Comprehend the Mechanism of Raman Effect: classically and quantum mechanically
3. Learn ,analyze and determine the complex molecular structure form Raman and Infrared Spectroscopy
4. Develop an understanding about Electronic Spectra of Diatomic Molecules.
5. Understand the applications of electronic spectra to transition metal complexes.
6. Study the basic concepts of Nuclear Magnetic Resonance Spectroscopy and its instrumentation.
7. Develop knowledge about Nuclear Magnetic Resonance, Quantum Description of Nuclear Magnetic Resonance, Instrumentation, Chemical Shift, Spin-Spin Coupling.

Unit-I

Raman Spectroscopy: Introduction: Characteristic properties of Raman Lines; Difference between Raman and Infrared Spectra; Mechanism of Raman Effect: Classical theory of Raman Effect, (a) Effect of vibrations, (b) Effect of Rotation; Quantum theory of Raman Effect, Pure Rotational Raman Spectra, Polarization of light and Raman Effect, Structure determination form Raman and Infrared Spectroscopy, Instrumentation of Raman Spectroscopy.

Unit -II

Electronic Spectroscopy: Electronic Spectra of Diatomic Molecules, The Born-Oppenheimer Approximation, Vibrational Coarse Structure, Frank-Condon Principle, Dissociation energy and Dissociation Products, Rotational Fine Structure of Electronic-Vibration Transitions, Fortrat Diagram, Predissociation, Applications of Electronic Spectra to Transition Metal Complexes.

Unit-III

Nuclear Magnetic Spectroscopy: Nuclear Magnetic Resonance, Quantum Description of Nuclear Magnetic Resonance, Instrumentation, Chemical Shift, Spin-Spin Coupling, Applications of NMR Spectroscopy, Limitations of NMR Spectroscopy.

Unit-IV

Electron Spin Resonance Spectroscopy: Electron Spin Resonance, Types of Substances, Comparison between NMR and ESR, Instrumentation, Presentation of ESR spectrum, Hyperfine Splitting, Determination of g value, Line width, Applications of ESR Spectroscopy.

Text and References books

1. Gurdeep R. Chatwal and Sham K. Anand, *Spectroscopy* (Atomic and Molecular) (Himalaya Publishers)

2. C. N. Banwell, Fundamentals of Molecular Spectroscopy. (Tata Mcgraw-Hill Publishers Company Ltd.)

3. Gerhard Herzberg, Infrared and Raman Spectra (D. Vannostrand Company, New York)

Semester - II

Core Paper 6:
PHY II – 202 [Classical Mechanics]

CLO- Students will be able to

1. Understand analytical methods of mechanics based on generalised coordinates of momenta and solve the practical problems using these concepts.
2. Understand and demonstrate the classical concepts of Physics
3. Understand the drawbacks of Newtonian Mechanics and the establishment of Classical Mechanics.
4. Develop mathematical formulation of physical problems using Lagrangian and Hamiltonian formalisms**.**
5. Demonstrate and solve new problems dealing with the classical aspects of Physics.
6. Apply the concepts of Poisson's Bracket algebra and its implementation in Quantum mechanical formulations.

Unit-I

Constraints and their classifications, D'Alembert's principle, Generalized coordinates; Lagrange's equations, Gauge invariance, Generalized coordinates and momenta; Integrals of motion; Symmetries of space and time with conservation laws.

Unit-II

Rotating frames; Inertial forces; Terrestrial and astronomical applications of Coriolis force, Centralforce; Definition and characteristics, Two-body problem; Kepler's laws and equations, Artificialsatellites; Rutherford scattering.

Unit-III

The Hamiltonian function, Hamilton's equation of motion, Hamilton's principle, modified Hamilton's principle, Derivation of Hamilton's equation from variational principle, Principle of least action.

Unit-IV

Canonical transformation, Generating function, Poisson bracket and their properties, Invariance of Poisson bracket with respect to canonical transformation, equation of motion in Poisson bracket form, Hamilton-Jacobi equation, Hamilton's characteristics or principle function, Hamilton-Jacobi equation for Hamilton's characteristic function, Jacobi's identity, Small oscillation, Normal modes and coordinates.

Text and Reference Books

1. N. C. Rana and P. S. Joag: Classical Mechanics (Mcgraw-Hill Education (India) (P)Ltd.)
2. H. Goldstein: Classical Mechanics (Narosa Publishing House, New Delhi)
3. A. Sommerfeld: Mechanics (Lectures on theoretical Physics Vol.1, Acadmic Press)
4. I. Peroceival and D. Richards: Introduction to Dynamics (Cambridge University Press)
5. J. C. Upadhyaya: Classical Mechanics (Ramprasad and Sons)

Semester - II

Core Paper 7:
PHY III – 203 [Quantum Mechanics-II]

CLO- Students will be able to

1. Develop the variation method and applied it to Ground state of helium

2. Learn the development of time-dependent perturbation theory and WKB method and its applications to α-decay of radioactive nucleus.
3. Understand the phenomena of collisions and idea about center of mass and laboratory frames and their correlation.
4. Develop the methods of the Semi classical theory of radiation, Transition probability for absorption and induced emission.
5. Study about the Electric dipole and forbidden transitions and their Selection rules.

Unit-I

Variation method, Ground state of helium, Vander wall's interaction, Polarizability of hydrogen, Exchange degeneracy.

Unit-II

Time-dependent perturbation theory, WKB method, α-decay of radioactive nucleus, Penetration ofbarrier, Adiabatic approximation, Sudden approximation.

Unit-III

Identical particles; Symmetric and anti-symmetric wave functions, Collision of identical particles,Spin angular momentum, Spin functions for a many-electron system.

Unit-IV

Semi classical theory of radiation; Transition probability for absorption and induced emission,Electric dipole and forbidden transitions; Selection rules.

Text and reference books

1. L I Schiff: Quantum Mechanics, (Mcgraw-Hill Education (India) (P) Ltd.)
2. S Gasiorowicz: Quantum Physics (Wiley)
3. B Craseman and JD Powell: Quantum Mechanics, (Addison – Wesley Publishing Company)
4. A P Messiah: Quantum Mechanics, (North - Holland)
5. J J Sakurai: Modern Quantum Mechanics, (Pearson Education, Singapore)
6. Mathews and Venkatesan: Quantum Mechanics, (Tata Mcgraw-Hill Publishers Company Ltd.)

Semester - II

Core Paper 8:

PHY – 204 [Electronic Devices]

CLO- Students will be able to

1. Learn basic concepts of transistors and their applications to MOSFET, JFET etc.
2. Study about junction transistor and their applications.
3. Comprehend the knowledge about different types of microwave devices including Impatt diodes and parametric devices.
4. Learn about Memory devices, Charge coupled devices.
5. Gain the knowledge about basics of digital electronics: gates and its applications.
6. Learn about oscillators of various types.
7. Learn about Voltage regulators and its classification.

Unit-I

(i)Transistors: JFET, BJT, MOSFET and MESFET: Structure, working, derivations of equationsfor I-V characteristics under different conditions, High frequency limits.

(ii) Microwave devices: Tunnel diode, Transfer electron devices (Gunn diode), Avalanche transittime devices, Impatt diodes and parametric devices.

Unit-II

(i) Memory devices: Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, NON-volatile-NMOS, Magnetic, Optical and Ferroelectrics memories, Charge coupled devices (CCD).

(ii) Transistor as a switch, OR, AND and NOT gates; NOR and NAND gates, Boolean algebra, Demorgan's theorem; Exclusive OR gates; Decoder/Demultiplexer data selector/multiplexer;Encoder.

Unit-III

Oscillators: The phase shift oscillator, Wein bridge oscillator, LC-tunable oscillators, Multivibrator; Monostable and Astable, Comparators, Square wave and triangle wave generators.

Unit-IV

Voltage regulators: Fixed voltage regulators, Adjustable voltage regulators, Switching regulators.

Text and reference books

1. S M Sze: Semiconductor devices, (John Wiley & Sons)

2. M S Tyagi: Introduction to semiconductor materials and devices, (John Wiley & Sons)

3. M Sayer and A Mansingh: Measurement, instrumentation and experimental design in physics and engineering, (Prentice Hall of India, New Delhi)

4. AjoyGhatak and K Thyagarajan: Optical electronics, (Cambridge University Press)

5. J Millmann and C CHalkias: Integrated electronic: Analog and digital circuits and systems, (Tata Mcgraw-Hill Education, New Delhi)

6. G K Mithal: Electronic devices and circuits, (Khanna Publishers)

Semester - II

Soft Skill and Ability Enhancement (Elective Generic)

PHY – 105[Communication Skills]

CLO- Students will be able to

1. Understand the Dimensions and directions of communication, means of communication, 7C's for effective communication.
2. Understand the Importance of Listening Skills, good & bad listening, communication channels, types of communication medium- audio, video, digital, barriers of communication.
3. Learn effective public speaking skills and its principles, awareness of the practical significance of good communication and negotiation skills.
4. Acquire competency in reporting and drafting.

Unit I: Introduction

Definition, nature, elements and importance of communication, principles and practices, models of communication, types of communication.

Unit II: Communication Skills and Soft Skills

Interviewing and group discussion, resume preparation, etiquette and manners, self-management, body and sign language, presentation skills, feedback & questioning technique: objectiveness in argument (Both one on one and in groups).

Unit III: Concept of effective Communication

Dimensions and directions of communication, means of communication, 7C's for effective communication.

Unit IV: Listening Skills

Importance of Listening Skills, good & bad listening, communication channels, types of communication medium- audio, video, digital, barriers of communication.

Unit V: Public speaking and reporting

Effective public speaking and its principles, interpretation and techniques of report writing, letter writing, negotiation skills.

Text and reference reading:

1. Business Communication- Royan and V. lesikar, John D. Pettit, JR. Richard D. Irwin, INC
2. Business Communication- K.K. Sinha
3. Business Etiquettes- David Robinson
4. Business Communication- Dr. Nageshwar Rao and Dr. R.P. Das
5. Effective Business Communication- Morphy Richards

M. Sc. II Semester
PHY – 206[Laboratory Course-II (Non- Electrical)

At least 10 Practicals based on Optics, Mechanics etc. (other than electrical based)

M. Sc. II Semester
PHY – 207 [Comprehensive Viva Voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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Semester - III

Core Paper 9:
PHY – 301 [Condensed Matter Physics-I]

CLO- Students will be able to

1. Learn basics of crystal structure and physics of lattice dynamics.

2. Gain knowledge of the physics of different types of material like magnetic materials, dielectric materials, metals and their properties.
3. Increase knowledge about different modes of lattice vibrations.
4. Understand the physics of insulators, semiconductor and conductors with special emphasis on the elementary band theory of semiconductors.
5. Comprehend the basic theory of superconductors. Type I and II superconductors, their Properties and physical concept of BCS theory.

Unit-I

(1) Crystal structure and reciprocal lattice; Crystal structure and Bravais lattice, Primitive unit cell, Wigner Seitz cell, Reciprocal lattice, Brillouin zone.

(2) X-ray diffraction: Bragg formulation, Van Laue formulation of X-ray diffraction, Ewaldconstruction, Laue method, Debye-Scherrer method.

Unit-II

Lattice vibration, Normal modes of a one-dimensional mono-atomic lattice, Normalmodes of one-dimensional diatomic lattice, Two ions per cell, The acoustic and optical modes of vibrations, Connection with the theory of elasticity.

Unit-III

Band theory-I: Periodic potential and Bloch's theorem, Proof of Bloch theorem, Born-Von-Karman boundary condition, Fermi surface, Density of levels, Schrödinger equation in a weak periodic potential (nearly free electron), Energy bands in one dimension, Construction of Fermi surface.

Unit-IV

Band theory-II: Tight binding method, Cellular method, Muffin-Tin potential, Augmented Plane wave (APW) method, Orthogonalised plane wave (OPW) method, de Haas-Van-Alphen effect.

Text and References Books

1. Solid State Physics: N. W. Ashcroft and N. D. Mermin (Harcourt Asia PTE Ltd.)
2. Introduction to Solid State Physics: C. Kittel (John Wiley and Sons, II and III Ed.)
3. Intermediate Quantum theory of Crystalline Solids: A. E. Animalu (Prentice Hall of India Pvt. Ltd.)

5. Principles of Condensed Matter Physics: P. M. Chaikin and T. C. Lubensky (Cambridge University Press)

Semester - III

Core Paper 10:
PHY – 302 [Nuclear and Particle Physics -I]

CLO- Students will be able to

1. Understand miscellaneous aspects of nuclear structure, masses and binding energies of nuclei.
2. Understand Physics behind the liquid drop model, semi empirical mass formula, magnetic dipole moments, electric quadrupole moments.
3. Develop the understanding about Accelerators, Synchrocyclotron, proton synchrotron, variable energy cyclotron.
4. Learn basic mechanism of Detectors: GM counters, scintillation detectors, semiconductor radiation detector, magnetic Beta-ray spectrometer scintillation, Gamma-ray spectrometer.
5. Understand the theory of nuclear forces.

Unit-I

Introduction to the Nucleus: Mass, Charge and constitution of the nucleus, nuclear size and the distribution of nucleus. Energies of nucleus, angular momentum. Miscellaneous aspects of nuclear structure, masses and binding energies of nuclei. The liquid drop model and semiempirical mass formula, magnetic dipole moments, electric quadrupole moments.

Unit -II

Experimental nuclear physics: Accelerators, Synchrocyclotron, proton synchrotron, variable energy cyclotron. Detectors: GM counters, scintillation detectors, semiconductor radiation detector, magnetic Beta-ray spectrometer scintillation, Gamma-ray spectrometer.

Unit-III

The nuclear force: the deuteron problem, spin states of two nucleon system effects of Pauli's exclusion principle. Magnetic dipole and electric quadrupole moments of a deuteron, The tensor force, exchange forces, meson theory of nuclear force, The nuclear force as we know it.

Unit-IV

Nuclear structure: The independent particle model, empirical rules for the ground states of the model, the shell model. The unified model; Vibrational and rotational states.

Text and Reference Books:

1. Introductory nuclear physics by Y.R. Waghmare (Oxford and IBH)

2. Concepts of nuclear physics by B.L. Cohen (TMH)

3. Experimental Nuclear Physics by R.M. Singru (Wiley- Eastern)

Semester - III

Core Paper 11:
PHY – 303 [Advanced Quantum Mechanics -I]

CLO- Students will be able to

1. Learn the Fundamentals of Angular momentum matrices, Pauli's spin matrices.
2. Formulate addition of angular momentum and find out the possible values of J-Clebsh-Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1$, $j_2=1/2$.
3. Gain knowledge about identical particles, Symmetrization postulate, Algebraic approach to Bose and Fermi statistics, Parastatistics, Quantization and spin statistics connection.
4. Learn the quantum theory of radiation, The Hamiltonian quantization of the radiation field (second quantization), Creation and Annihilation operator.
5. Understand basic concepts of special theory of relativity and its applications to dynamical systems of particles.
6. Learn determination of Klein-Gordon equation, Dirac equation, Probability and Current densities, Covariance of Dirac equation.
7. Develop the Plane wave solutions and their applications .

Unit-I: Angular Momentum

Angular Momentum: Time displacement symmetry and conservation of energy, Angular momentum and rotation, Rotational Symmetry and conservation of angular momentum, Degeneracy, Reflection invariance and parity, Eigen values of angular momentum operators, Angular momentum matrices, Pauli's spin matrices.Addition of angular momentum, The possible values of J-Clebsh-Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1$, $j_2=1/2$

Unit-II: Bose, Fermi and Particle and Parastatistics

Identical particles in quantum mechanics and permutation symmetry, Symmetrization postulate, Algebraic approach to Bose and Fermi statistics, Parastatistics, Quantization and spinstatistics connection.

Unit-III: Radiation Theory

The quantum theory of radiation, The Hamiltonian quantization of the radiation field(second quantization), Creation and Annihilation operator.

Unit-IV: Relativistic Theory

The Klein-Gordon equation, The Dirac equation, Probability and Current densities, Covariance of Dirac equation, Plane wave solutions. The electron in electric and magnetic field. Dirac equation in central potential, Energy levels of hydrogen atom, The hole theory and positrons, Prediction of the spin angular momentum.

Text and Reference Books:

1. A.K. Ghatak and S. Loknathan: Quantum Mechanics: Theory and Applications (Macmillan India Ltd.)
2. S. N. Biswas: Quantum Mechanics (Books & Allied (P) Ltd.)
3. Messiah: Quantum Mechanics (Dover Publications)

Semester - III

Core Elective Centric (any one) Paper 12 (A):
PHY – 304(A) [Advanced Electronics (Digital Electronics)]

CLO- Students will be able to understand the

1. Design of Integrated Circuits Technology, Basic Monolithic Integrated circuits, Epitaxial growth, masking and Etching, Diffusion of impurities.
2. Construction and working of OP-AMPs and design waveform generator circuits.
3. Working of differentiator and integrator.
4. Construction of TTL circuits: 7400 devices, TTL characteristics, TTL overview, Encoders and Decoders.
5. Concept of Karnaugh maps and Karnaugh simplification.
6. Adder and substractor circuits.
7. Construction and working of FLIP FLOPS.

Unit-I: Integrated Circuits and Operational Amplifiers

Integrated Circuits Technology, Basic Monolithic Integrated circuits, Epitaxial growth, masking and Etching, Diffusion of impurities, Transistors for monolithic circuits, monolithic diodes, Integrated Resistors, Integrated capacitors and Inductors, Monolithic circuit layout, Additional Isolation methods, Large scale and Medium scale Integration (LSI and MSI), the Metal-Semiconductor contact.

Op-Amp: Operational Amplifier, Inverting and Non-inverting amplifier, Difference amplifier, Analog Integration and Differentiation.

Unit-II: TTL circuits and Karnaugh Maps

TTL circuits: 7400 devices, TTL characteristics, TTL overview, Encoders and Decoders, AND-OR-INVERT gates, Karnaugh maps and Karnaugh simplification.

Unit-III: Digital Electronics and system

Arithmetic logic unit: Half adder, Binary adder, 2's compliment, 2's compliment adder and substractor. Flip-Flops: RS-latches, Level clocking, D-latches and flip-flops, JK master slave flip-flops.

Unit-IV: Registers and Memories

Registers and counters: Buffer registers, Shift register, Ripple counters, Synchronouscounters, Ring counters, other counters and Bus-organized computer.

Digital to Analog converters, Analog to digital converters.

Text and Reference Books:

1. Digital Principles and Application: A. P. Malvino& D. P. Leech (Tata McGraw-Hill Education (P) Ltd.)

2. Op-Amps & Linear Integrated circuits: R. A. Gayakwad (Prentice Hall, 2000)

3. Electronics: D. S. Mathur (S. Chand Publishing)

4. Digital Communications: W. Tomasi (Prentice Hall)

5. Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Education (P) Ltd.)

6. Integrated Circuits: Millman Halkias (Tata McGraw-Hill Education(P) Ltd.)

Semester - III

Core Elective Centric (any one) Paper 12 (B):
PHY – 304(B) [Advanced Solid State Physics]

CLO- Students will be able to

1. Understand determination of the Elastic constant.
2. Learn dynamics of sound wave propagation in crystal of cubic symmetry.
3. Learn explanation of optical and thermal electronic excitation, optical effects in semiconductors, formation and the origin of band structure in a solid.
4. Understand Boltzmann transport equation and its application for the study of transport phenomena due to electric and magnetic fields, density and temperature gradients.

Unit-I

Elastic constants and elastic waves: Analysis of elastic stains**,** Elastic compliance and stiffness constants, Central and non-central forces, velocity of sound and crystal elasticity, Dynamical equations of sound wave propagation in crystal of cubic symmetry. Experimental determination of elastic constants.

Unit-II

Optical Properties: Electronic properties of alkalihalides, Optical and thermal electronic excitation, Ultravoilet spectrum of the alkali halides, Exciton, Influence of lattice defects on electronic levels, ionic polarizability, Restrahlen, polarization waves in ionic crystals. Lyddane-Sachs-Teller relation. Optical effects in semiconductors, Direct and indirect transitions, Free carrier absorption

Luminescence, Excitation and emission. Decay mechanisms, Traps, Thermoluminescence, Electroluminescence, Luminescence in semiconductors and ionic solids.

Unit-III

Transport Properties: Boltzmann transport equation, its application for the study of transport phenomena due to electric and magnetic fields, density and temperature gradients. Solution of Boltzmann equation under relaxation time approximation, Transport coefficients, Scattering mechanisms, Calculation of the relaxation time for scattering due to impurity and thermal vibrations of lattice.

Unit-IV

Ferroelecticity: Classification and general properties of ferroelectrics, Dipole theory. Thermodynamics of ferroelectric transitions, Low frequency optical phonons, Exprinents with strontium titanate. Ferroelectric domains antiferroelectricity. Piezo and pyroelectricity.

Text and Reference Books:

1. Introduction to solid state physics- C. Kittel (John Wiley 5th edition).
2. Solid state physics- A.J. Dekkar (MachMillan).
3. Solid State Physics- Ed Seitz and Turnbull (Academic Press) Vol. 2 and 4.
4. The use of Thin Films in Physical Investigation- Ed. J.C. Anderson (Academic Press).
5. Energy Band Theory- J. Callaway (Academic).
6. Wave Mechanics of Crystalline Solids- R.A. Smith (Chapman and Hall).
7. The Theory and Properties of Metals and Alloys- M.F. Mott and Jones (Dover).

Semester - III

Core Elective Centric (any one) Paper 12 (C):

PHY – 304(C) [Plasma Physics]

CLO- Students will be able to

1. Understand the fundamental concept of plasma and its applications.
2. Develop the methodology of plasma as fluids.
3. Learn representation of waves in plasma and its experimental applications.
4. Comprehend the knowledge of solid state plasma and its applications.

Unit-I

Occurrence of Plasmas in nature: Definition of plasma, Concept of temperature, Debye shielding, The plasma parameter, Criteria for plasma, Applications of plasma physics with elementary idea about gas discharges, Controlled thermonuclear fusion, Space physics, Astro-physical Plasma, MHD energy conversion and ion propulsion, Solid state plasma, Laser and laser fusion.

Single particle motions: Uniform E and B fields, Gravitational fields, Non uniform B field, Grade B drift, curvature drift, Non uniform E field, Time varying E field, Time varying B field, Guiding center drifts. The first adiabatic invariant, second adiabatic invariant.

Unit-II

Plasma as fluids: Relation of plasma physics to electromagnetic, classical treatment of magnetic materials and dielectrics. Dielectric constants of plasma fluids, equations of motion, stress tensor collisions, equations of continuity, equation of state, Complete set of fluid equations.

Equilibrium and Stability: Hydromagnetic equilibrium, Concept of diffusion of magnetic field into a plasma, Classification of instability, Resistive drift waves.

Unit-III

Waves in plasmas: Representation of waves group velocity, Plasma oscillations, Electron plasma waves, Sound waves, ion waves, Comparision of electron and ion waves, Electrostatic electron oscillations perpendicular to B. Electrostatic ion waves perpendicular to B, The lower hybrid frequency electromagnetic waves. Experimental applications, Electromagnetic wave perpendicular to B, Cutoff and resonances, Electromagnetic wave parallel to magnetic field. Experimental consequences of Magnetosonic waves. The C.M.A. diagram.

Unit-IV

Kinetic theory: Meaning of distribution function, equation of Kinetic theory, Derivation of fluid equation, Landau damping without contour integrations, Meaning of Landau damping. The Kinetic energy of a beam of electrons, Experimental verification.

Solid state plasma: Introduction, parameters and physical laws, Passive electro kinetic wave propagation in an infinite and in a finite medium, Macroscopic model of piezoelectric media, Longitudinal Phonon-Plasmon interactions, Transverse Phonon- Helicon interactions, Solid state plasma technology. Travelling wave amplifiers, High frequency isolator, the oscillator, the mediators.

Text and Reference Books:

1. Introduction to Plasma Physics- F.F. Chen, Plenum Press, III Print.
2. Principles of Plasma Mechanics- B.B. Charkraborty, Wiley Eastern Limited.
3. Solid State Plasmas- M.F. Hoyaux, Pion Limited, London, 1970.
4. Wave Interactions in solid state plasmas- M.C. Steele and B. Vural, McGraw Hill, New York, 1969.

Semester - III

Core Elective Centric (any one) Paper 12 (D):
PHY – 304(D) [Spectroscopy]

CLO- Students will be able to understand

1. Structure of atoms and the origin of the observed spectra.
2. The information obtained from width of spectral lines.
3. Magnetic interaction in single electron spectra.
4. Working principle of various spectroscopic techniques.

Unit-I

Atomic Spectra: Coupling schemes, LS and JJ couplings in spectra of two valence electron systems.

Hyperfine structure: Hyperfine multiplets, Magnetic interaction in single electron spectra, Basic relation Hydrogen like atoms: Relativistic and volume correction.

Width of spectral lines: the different causes of line width, The natural or radiation width, Doppler width, External effects.

Molecular Orbitals: Spectroscopic designations for molecules. The unified atom model, separated atom model, Molecular orbitals, United-separated atom. Correlation diagrams.

Unit-II

Microwave spectroscopy: Theory of microwave spectroscopy, Linear Molecules, spherical top molecules, symmetric top molecules, Asymmetric top molecules, The stark effect, Instrumentation for Microwave spectroscopy, Applications of microwave spectroscopy.

Infrared spectroscopy: Theory of IR absorption spectroscopy, Linear Molecules, Symmetric top molecules, Asymmetric molecules, Instrumentation, Single beam and double beam, spectrophotometers, Modes of vibration of atoms in polyatomic molecules, Applications of infrared spectroscopy to organic and inorganic compounds and complexes.

Unit-III

Ultraviolet spectroscopy: Origin and theory of ultraviolet spectra, choice of solvents, Instrumentation, Application of UV absorption spectroscopy.

Unit-IV

X-Ray spectroscopy: Theory of emission spectra-classical, semiclassical and quantum theory of emission of X-ray lines, X-ray energy level diagrams, selection rules of electric and magnetic dipole and higher multipole transitions, Spin doubles, The T-sum and permanence rules Screening doublets and screening constants, Relative intensities in X-ray spectra, Non-diagram lines (theory). Structure of absorption edges and chemical effects in X-ray absorption spectra. Theory of EXAFS; experimental details and its uses.

Text and Reference Books:

1. Spectroscopy part I & II – B. Strughan and S. Walkar (Chapman and Hall)
2. Spectra of Diatomic molecules- G. Herzberg (Vannostrand).
3. Atomic spectra- H.E. White (McGraw Hill).
4. X-ray spectroscopy- B.K. Agrawal (Springer Verlag).
5. Elements of diatomic molecular spectra- H. Brian Dunford, (Addission Wesley).

Semester - III

Soft Skill and Ability Enhancement (Elective Generic)
PHY – 305[Personality Development]

CLO- Students will be able to

1. Learn the basics of Personality Development- concept, types, role and impact, developing self-awareness, projecting a winning personality.
2. Understand Personality Assessment and testing- resume writing- types, contents, formats, interviewing skill, group discussion, JAM sessions, and persuasive communication.
3. Practice on oral/spoken communication skill and testing-voice and accent, feedback and questioning techniques, objective in an argument.
4. Learn the Skills and techniques, etiquette, project/assignment presentation, role play and body language, impression management.
5. Study Leadership activities, motivation activities, team building activities, stress and time management techniques, creativity and ideation.

Unit I: Introduction

Personality Development- concept, types, role and impact, developing self-awareness, projecting winning personality.

Unit II: Personality Assessment

Personality Assessment and testing- resume writing- types, contents, formats, interviewing skill, group discussion, JAM sessions, persuasive communication.

Unit III: Communication Skill

Practice on oral/spoken communication skill and testing-voice and accent, feedback and questioning techniques, objective in an argument.

Unit IV: Presentation Skill

Skills and techniques, etiquette, project/assignment presentation, role play and body language, impression management.

Unit V: Personality Development activities

Leadership activities, motivation activities, team building activities, stress and time management techniques, creativity and ideation.

Text and reference books

1. Business Communication- Royan and V. lesikar, John D. Pettit, JR. Richard D. Irwin, INC
2. Personality Development and soft skills- Barun K. Mitra, (Oxford Publisher).
3. Personality Development- Rajiv K. Mishra, (Rupa publisher).

M. Sc. III Semester
PHY – 306 Laboratory Course –III (General)

At least 10 Practicals based on Solid State Physics, Spectroscopy, Nuclear Physics etc (other than electronics)

M. Sc. III Semester
PHY – [307 Comprehensive Viva voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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Semester - IV

Core Paper 13:
PHY – 401 [Condensed Matter Physics-II]

CLO - Students will be able to understand

1. Electron dynamics in a DC electric field
2. Defects in crystal structures.
3. Formation of band structure in a solid and the origin of band gap in semiconductors.
4. Differentiate between intrinsic and extrinsic semiconductors.
5. Hall Effect and its applications.
6. Theory of semiconductor, its classifications and applications.
7. Superconductivity phenomenon and its parameters related to possible applications.

Unit-I

Electron dynamics: The semi-classical model; Motion in a DC electric field, the holes, Motion in a uniform magnetic field, Motion in perpendicular uniform electric and magnetic fields, Hall effect and magneto-resistance.

The semi-classical theory of conduction in metals: The relaxation time approximation, DC electric conductivity, AC electric conductivity, Thermal conductivity.

Unit-II

Defects in Solid: Number of vacancies and interstitial as a function of temperature, Diffusion: Self-diffusion and chemical diffusion, Fick's law, Edge and screw dislocation, Slip, Burger vector, Dislocation mobility and density, Interaction between dislocations, Color center, Excitons, Elementary idea about luminescence.

Unit-III

Semiconductors: Typical semiconductor band structures, effective mass in semiconductors, Cyclotron resonance, Number of carriers in thermal equilibrium: Intrinsic and extrinsic cases, Population of impurity levels in thermal equilibrium; Thermal equilibrium carrier density of impure semiconductors, p-n junction in equilibrium.

Unit-IV

Superconductivity: Experimental surveys, Meissner effect, Heat capacity, Energy gap, Microwaves and infrared properties. Thermodynamics of superconducting transition, London equation, Qualitative idea of BCS theory, Type-I and Type-II superconductors, Superconducting devices, isotope effect, Flux quantization, Single particle tunneling, Josephson tunneling, High Tc superconductors.

Text and References Books:

1. Solid State Physics: Neil W. Ashcroft and N. David Mermin (Harcourt college Publishers)

2. Solid State Physics: C. Kittel (John Wiley and Sons, VII Ed.)

3. Intermediate Solid State Physics: AE Animalu (Prentice Hall of India Pvt. Ltd.)

4. Principle of Condensed matter Physics: P.M. Chaikin and T.C.Lubensky (Cambridge publishers).

5. Elementary Solid State Physics: Principles and Applications: M.A. Omar (Addison-Wesley publishing company)

Semester - IV

Core Paper 14:
PHY – 402 [Nuclear and Particle Physics -II]

CLO - Students will be able to

1. Understand the fundamental radioactivity and mechanisms- alpha, beta and gamma decay.
2. Outline nuclear reaction types
3. Understand the origin of stellar energy.
4. Understand radioactive decays and its quantum mechanical formulations.
5. Learn about classification of elementary particles.
6. Have a basic understanding of Group theory and the special unitary group.
7. Acquire knowledge about Quark model and explain the standard model of particle physics.

Unit-I

Radioactivity: Alpha decay, calculation of alpha decay rates. The Gamma-decay,transition probability of gamma decay, many particle configuration transition, internal conversion.

Unit-II

Beta Decay: experimental observations, shape of beta spectrum, neutrino hypothesis. The Kurie plot, Fermi's theory of beta decay, allowed transitions, parity non-conservation in beta decay and its experimental confirmation.

Unit-III

Nuclear reactions: Elastic scattering reaction cross section, the collision amplitude, elastic scattering of S-wave neutrons. Scattering of charged particle, cross section in terms of the scattering matrix in the general case. Reaction mechanism, compound nuclear reactions. Statistical model nuclear reaction.

Nuclear Fission: Neutron emission in fission, Fissile and fertile materials, theory of fission, Nuclear fission and thermonuclear reactions.

Unit-IV

Fundamental particles (Descriptive): The particles and force between them. Enumeration of various quantum numbers, properties of the muons, pions, kaons, hyperons, quarks. Partons and the $J\Psi$ contemporary situation regarding elementary particles.

Text and References Books:

1. Introductory Nuclear Physics by Y.R. Waghmare (Oxford and IBH)
2. Concepts of Nuclear Physics by B.L. Cohen (TMH)
3. Experimental Nuclear Physics by R.M. Singru (Wiley- Eastern)

Semester - IV

Core Paper 15:
PHY – 403 [Advanced Quantum Mechanics -II]

CLO - Students will be able to

1. Understand scattering theory and its applications.
2. Apply scattering theory in elastic and inelastic collisions.
3. Solve the equation of motion in a centrally symmetric field.
4. Learn elements of field quantization.

Unit-I

Scattering Theory: Differential scattering cross section, Total scattering cross section, Relationship between the scattering cross section to the wave function, the scattering amplitude, Method of partial waves, Expansion of plane wave in terms of partial waves, Scattering by a central potential, the scattering length, Scattering by a square well potential, Resonance scattering.

Unit-II

The Born approximation, Criterion for the validity of the Born approximation, Scattering of electrons to atoms.

Unit-III

Elements of Field Quantization: Quantization of the field, Non-relativistic fields, System of Bosons, System of Fermions, Commutators and anti-commutators, unequal times.

Unit-IV

Relativistic field, The Klein-Gorden field, Invariant delta functions, The Dirac field, Spins and statistics, covariant anti-commutation relations, Feynman diagrams.

Text and Reference Books:

1. V. K. Thankappan: Quantum Mechanics (New Age International Publishers)

2. R. L. Katiyar: Relativistic Quantum Mechanics and Quantum Fields (Campus Book International)

3. A. J. Ghatak and S. Loknathan: Quantum Mechanics; Theory and Applications
(Macmillan India Ltd.)

Semester - IV

Core Elective Centric (any one) Paper 16 (A):
PHY – 404(A) [Microprocessor]

CLO- Students will be able to

1. Describe architecture of microprocessor and design programs.
2. Articulate different memory interfacing schemes.
3. Articulate the programmable peripheral interface.

4. Differentiate signals and apply signal transforms
5. Understand construction and working of multivibrator and its types.

Unit-I

Microprocessor-I

(a) Introduction to microprocessors

(b) Programming and languages: Relationship between electronics and programming. Flowcharts, Programming languages, Assembly languages.

(c) System overview: Computer architecture, Microprocessor architecture, specific microprocessor -8085 only.

Unit-II

(a) Data transfer instructions: CPU control instructions, Data transfer instructions, Microprocessor 8085 family only.

(b) Addressing modes I: Concept of addressing mode, Paging concept, Basic addressing modes.Microprocessor-8085 family only

(c) Arithmetic and flags: Microprocessors and numbers, Arithmetic instructions, Flaginstructions, Microprocessor 8085 family only.

(d) Logic instructions: The AND instruction, The OR instruction, X-OR, X-NOR and NOTinstructions.

Unit-III: SAP

(a) Bistable multivibrators: Stable state of a binary, Fixed bias transistor binary, Self biased transistor binary.

(b) Simple-as-possible computer (SAP-1): Architecture, Instruction set, Programming, Fetch cycle, Execution cycle, Microprogramming, Schematic diagram, Micro Programming.

Unit-IV

(a) Simple-as-possible computer-II (SAP-2): Bidirectional resistors, Architectures, Memory reference instructions, Registers instruction, Jump and call instructions, Logic instructions.

(b) Simple-as-possible computers (SAP-3): Programming model, Arithmetic instructions, Increments, decrements and multiples Logic instructions.

Text and Reference Books:

1. Microprocessor Architecture Programming and Applications: R. S. Gaonkar.

2. Digital Computer Electronics: A. P. Malvino and Brown (Tata McGraw-Hill Education(P) Ltd.)

Semester - IV

Core Elective Centric (any one) Paper 16 (B):
PHY – 404(B) [Laser & applications]

CLO- Students will be able to understand

1. Basic lasing mechanism, characteristics and working of different types of LASERs.
2. Basics of nonlinear optics and various nonlinear optical processes.
3. Applications of LASERs.

Unit-I

Interaction of radiation with matter: Stimulated and spontaneous emission, Einstein's A & B coefficients, line broadening mechanisms, gain and absorption coefficients, principles of laser, population inversion, population inversion in three and four level lasers, laser amplification, conductions for laser output.

Unit-II

Laser beam output modifications: Q-factor of laser oscillations, laser linewidth, resonators, stable and unstable resonators, a laser cavity, active and passive Q-switching, mode looking, detection of pulsed laser output.

Unit-III

Specific Laser and Pumping Mechanisms: Solid state rare earth ion lasers and optical pumping, Dye lasers and optical pumping, Electron impact excitation, Excitation Transfer, He-Ne lasers, Rate equation model of population inversion in He-Ne lasers, Radial gain variation in He-Ne laser tubes, CO_2 electric discharge lasers, Gas-Dynamic lasers, Free-Electron lasers, Semiconductor lasers.

Unit-IV

Elementary concepts of nonlinear optics: operating principles and characteristics, introduction second order optical susceptibility, parametric up and down conversion, second harmonic

generation, third order optical susceptibility, nonlinear refraction and absorption, optical phase conjugation.

Unit-V

Applications of lasers: Distance and Velocity Measurements, The Laser Gyroscope, Holography: The Essential Principle, Holography: Practical Aspects, Optical Communications, Lasers in Medicine: Ophthalmology.

Text and Reference Books:

1. Introduction to laser physics- K. Shimoda (Springer-Verlag Berlin Heidelberg GmbH)
2. An introduction to Laser and their applications- D.C. Oshea (Addison-Wesley,1977)
3. Quantum electronics- A. Yariv (John Wiley & sons, Inc.)
4. Optical electronics- A.K. Ghatak and K. Thyagarajan (Cambridge University Press)
5. Lasers - Fundamentals and applications: K. Thyagarajan and A.K. Ghatak (Springer)
6. Lasers: Peter W. Milonni and Joseph H. Eberly (John Wiley & sons, Inc.)
7. Nonlinear Optics- R W Boyd (Academic Press)

Semester - IV

Core Elective Centric (any one) Paper 16 (C):
PHY – 404(C) [Fiber optics & Integrated Optics]

CLO- Students will be able to understand

1. Concept of optical fiber and its characteristics.
2. Construction and working of optical fibre and optical fiber waveguide.
3. Fabrication of Cabling of Optical fiber.
4. Applications of optical fiber.
5. Basics of electrooptic and electroacoustic effects.

Unit-I

Introduction : The optical fiber, comparison of optical fiber with other inter connectors, concept of an optical waveguide, rays and modes, principal of light guidance in optical wave guides, fiber types. Electromagnetic analysis of simplest optical waveguide; basic wave guide equation, propagating modes of symmetric step index planar waveguide, TE modes of symmetric step

index planer waveguide, the relative magnitude of longitudinal component of electric and magnetic field, power associated with a mode, radiation modes, leaky modes.

Unit-II

Optical fiber waveguides: Scalar wave equation and modes of fiber, modal analysis for step index fiber, fractional power in the cone, modal analysis of parabolic index medium. Attenuation in optical fiber, pulse dispersion in optical fiber, losses at fiber splices, measurement of refractive index profile and spot size of an optical fiber.

Unit-III

Optical fiber fabrication and cabling: Material consideration, loss and band width limiting mechanisms, mechanical and thermal characteristics, perform fabrication of multicomponent glass fibers, mechanical consideration for optical fiber cabling, fiber cable design, example of cable design. Applications: fiber optic components and devices, fiber optic sensors.

Unit-V

EM wave propagation in anisotropic crystals: Index ellipsoid, index ellipsoid in presence of external electric field. Electrooptic (EO) effect in KDP crystals; EO devices, Acoustooptic (AO) effects. Raman-Nath and Bragg AO effect. AO devices.

Text and Reference Books:

1. An introduction to optical fibers- A. H. Cherin
2. Optical electronics- A. Ghatak& K. Thyagarajan
3. Optical fiber communication – G. Kasser
4. Theory of dielectrics optical waveguides – D. Marcuse
5. Fiber optics technology & applications- S.D. Personick
6. Fiber optics- N. S. Kapany
7. Integrated optics- D. Marcuse
8. Integrated optics- T. Tamir
9. Electromagnetic principle of integrated optics- D. Lee
10. Fiber Optic Communication System- G P Agrawal

Semester - IV

Core Elective Centric (any one) Paper 16 (D):
PHY – 404(D) [Physics of Nano materials]

CLO- Students will be able to understand

1. Difference between nanomaterials and bulk materials and their properties.
2. Various methods for the synthesis/growth of nanomaterials.
3. Role of confinement of the density of state function and so on the various properties exhibited by nanomaterials compared to bulk materials.
4. Various characterization tools required to study the structural, optical and electrical properties of nanomaterials.
5. Applications of Nanomaterials in various fields.

Unit-I

Systematic Development of Materials: Solid materials and their strength, Perspective of length, Nanoscience and nanotechnology, Nanostructures in nature, Quantum structures, Quantum confinement, Surface effects of nanomaterials, Prime materials, Carbon nanostructures, Metal Oxides, Bright future of nanotechnology.

Unit-II

Methods of Generation of Nanomaterials: Nanomaterials synthesis, Physical approaches; Arc discharge method, Laser ablation, Aerosol synthesis, Inert gas condensation, High energy ball milling, Chemical vapor deposition, Plasma synthesis method, Electro-deposition. Chemical approaches; Solvothermal synthesis, Hydrothermal Synthesis, Reverse micellar/ Micro-emulsion method, Sol gel synthesis, Microwave method, Sonochemical process, Co-precipitation.

Unit-III

Properties of Nanomaterials: Mechanical behavior, Optical Properties, Electrical Properties, Dielectric materials and properties, Magnetic properties, Electrochemical properties, Chemical sensing properties.

Unit-IV

Applications of Nanomaterials: Nanomaterials in medicine, energy sector, next generation computer technology, catalysis, water purification, communication sector, food, fabric industry, for the environment, automobiles, ceramics industry, veterinary applications.

Text and Reference Books:

1. Principles of Nanoscience and Nanotechnology; M.A. Shah &Tokeer Ahmad (Narosa) 2010.

2. Physics of Nanostructures; K.P. Jain (Narosa) 1987.

3. Physics of Low dimensional semiconductors; John H. Davies (Cambridge University Press).

M.Sc. IV Semester
PHY-405[Minor Project / Industrial Training]

The objective of this course is to impart work experience and training to students in actual working environment. Student can pursue project work or training in his/ her area of interest. A Minor project should be developed and its model and write-up should be submitted. A presentation based on it would be arranged.

M.Sc. IV Semester
PHY-406[Laboratory Course - IV (Electronics)]

At least 10 experiments based on digital electronics and microprocessor.

M. Sc. IV Semester
PHY – [407 Comprehensive Viva voce]

A Comprehensive viva voce examination will be conducted at the end of each semester of the programme by a board of four examiners.

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