ACHARYA NAGARJUNA UNIVERSITY

CENTRE FOR DISTANCE EDUCATION

NAGARJUNA NAGAR,

GUNTUR

ANDHRA PRADESH

PROGRAM PROJECT REPORT

03. MASTER OF SCIENCE (PHYSICS)

Master of Science (Physics)

PROGRAMME CODE: 3

MISSION :

The M.Sc. Physics program aims to impart quality education both at basic and advanced levels with emphasis on experimental aspects.

OBJECTIVES :

The objective of the course is to build a strong background in quantum mechanics, electronics, electrodynamics, condensed matter physics, nuclear physics, nano physics, computational physics, solar energy physics, thermodynamics, atomic and molecular physics. It is also a foundation for entry into M Phil or PhD.

RELEVANCE :

The M.Sc. (Physics) programme offered through Open and Distance Learning mode is purely relevant and aligned with the goals and mission of CDE, ANU. This programme is structued inorder to equip the learners with core competence in research and analytical aspects of scientific evolution there by new areas will be unfolded. This programme is helpful for enhancing the employability skills with the global perspective and conforming to the vision and mission of ANU.

NATURE OF PERSPECTIVE TARGET GROUP OF LEARNERS :

Aim of open and distance eduation is to enhance the academic competence in those who were deprived of higher education for various socio-economic reasons. This programme is designed for candidates which is helpful in their career advancement, updating the knowledge, upgrading their qualification for school teachers, Scientists, Laboratories etc.

SKILLS AND COMPETENCE OF THE PROGRAMME :

In consideration of the huge gap in education and industry and also in skill development now it is imperative on the part of every university to reach out every nooc and corner of the country where the institutions with significant infrastructure are not availble in order to elevate the status of the marginalised sections of the society especcially living in rural areas of the country. The only solution appears to be "open and distance education" and Acharya Nagarjuna University takes initiative by reaching out those unreached by ICT enabled blended mode of distance learning programmes. M.Sc. (Physics) propgramme is an innovative programme. The learning outcomes of this programme are as follows:

- Professional development of teachers.
- Incorporating generic transferrable skills and competencies
- To develop critical learning, anylitical skills and research skills.

INSTRUCTIONAL DESIGN: Course structure and detailed syllabi

CENTRE FOR DISTANCE EDUCATION: ACHARYANAGARJUNAUNIVERSITY

Master of Science (Physics) – Program Code: 03

Program Structure

Program code	Program	Internal assessment	External exams	Max. Marks	credits
SEMISTER 1					
101PH24	Classical Mechanics	30	70	100	4
102PH24	Introductory Quantum Mechanics	30	70	100	4
103PH24	Mathematical Physics	30	70	100	4
104PH24	Analog and Digital Electronics	30	70	100	4
	Practicals:				
105PH24	General Physics (Electricity&Optics) PRACTICAL	--	--	100	4
106PH24	Electronics PRACTICAL	--	--	100	4
SEMISTER 2					
201PH24	Statistical Mechanics	30	70	100	4
202PH24	Solid State Physics	30	70	100	4
203PH24	Quantum Dynamics and Scattering Theory	30	70	100	4
204PH24	Computational Methods and Programming	30	70	100	4
	Practicals:				
205PH24	General Physics (Spectroscopy) PRACTICAL	--	--	100	4
206PH24	Electronics PRACTICAL	--	--	100	4
SEMISTER 3					
301PH24	Nuclear and Particle Physics	30	70	100	4
302PH24	Advanced Quantum Mechanics	30	70	100	4
303PH24	Condensed Matter Physics - I	30	70	100	4
304PH24	Condensed Matter Physics - II	30	70	100	4
	Practicals:				
305PH24	Microprocessor & C Programming PRACTICAL			100	4
306PH24	Condensed Matter Physics PRACTICAL			100	4
SEMISTER 4					
401PH24	Electromagnetic Theory, Lasers and Modern Optics	30	70	100	4
402PH24	Atomic, Molecular and Resonance Spectroscopy	30	70	100	4
403PH24	Advances in Materials Science	30	70	100	4
404PH24	Advanced Condensed Matter Physics	30	70	100	4
	Practicals:				
405PH24	Advanced Electronics PRACTICAL	--	--	100	4
406PH24	Advanced Condensed Matter Physics PRACTICAL	--	--	100	4

Master of Science (Physics) - Syllabus
Semester 1
101PH24-CLASSICAL MECHANICS

Course Objectives:

- Introduction to basic ideas about Newtonian mechanics
- Initiation of mechanical system through derivative and problematic approaches
- Study of motion of the body in different systems of equation

Unit-I(Lagrangianmechanics)

Newtonian mechanics of one and many particle systems,Conservation laws, Constraints and their classification, principle of virtual work, D'Alembert's principle and Lagrange's equation of motion, Applications: linear harmonic oscillator, simple pendulum, compound pendulum, L-C Circuit, Lagrangian for a Charged Particle Moving in an Electromagnetic field.

Learning Outcomes:

- Learning concepts of mechanics of the systems for problematic analysis of the objects
- Lagrangian systems are useful to examination of the motion of the objects
- In view of Competitive exams problematic and derivational tactics in equation of motion in Lagrangianfrom D'Alembert's principle.

Unit-II (Hamilton's mechanics)

Deduction of Hamilton's principle from D'Alemberts principle, modified Hamilton's principle, Hamilton's principle and Lagrange's equations, generalized momentum and cyclic coordinates, Hamilton function H and conservation of energy, Hamilton's equation (Hamilton's canonical equations of motion), Simple application of the Hamilton principle- linear harmonic oscillator, simple pendulum, Δ-variation, principle of least action. Equationsofcanonical transformation, (Generating functions), examples of canonical transformations for a harmonic oscillator.

Learning Outcomes:

- To study the Hamilton's principle from D'Alemberts principle.
- To learn about oscillator mechanics and canonical transformations.

Unit-III (Poisson's bracket and Hamilton –Jacobi method)

Introduction to Poisson's bracket notation, equations of motion in Poisson bracket form, fundamentals of Poisson's bracket notation, angular momentum and Poisson brackets, Jacobi's identity.

Hamilton – Jacobi equation of Hamilton's principal function, The Harmonic oscillator problem as an example of the Hamilton – Jacobi Method, Hamilton –Jacobi equation for Hamilton's characteristic function, Action – angle variables.

Learning Outcomes:

- To study the equation of motion in Poisson bracket form
- In view of theory exams theory learning for Hamilton's-Jacobi equations.
- Learn about Hamilton –Jacobi equation for Hamilton's characteristic function.

Unit-IV (Dynamics of a rigid body)

The Euler angles-first rotation, second rotation and third rotation, angular momentum and inertia tensor, principal axes and principal moments of inertia, rotational kinetic energy of a rigid body, Euler's equations of motion of a rigid body, torque-free motion of a rigid body.

Learning Outcomes:

- Gained knowledge of The Euler angles-first rotation, second rotation and third rotation.
- Learn about motion and indication of rigid body through tensor, Euler equation of motion.

Unit-V (Special theory of relativity)

Introduction to special theory of relativity, Galilean transformations, principle of relativity, transformation of force from one inertial system to another, covariance of the physical laws, principle of relativity and speed of light, Lorentz transformations, consequences of Lorentz transformations, aberration of light from stars, relativistic Doppler's effect.

Learning Outcomes:

- Galilean transformations of relativistic mechanics.
- Covariance of the physical laws
- Relativistic Doppler's effect.

Course Outcomes:

- Students get knowledge on mechanics of the macroscopic things where Newton laws are applicable, can learn constrained motion of rigid bodies in one, two and three dimensions.
- Students can understand the motion of bodies similar to Hamilton and Lagrangian systems and resolve with practical approach.
- The students will know the concept of special theory of relativity.

Text and Reference Books

1.Classical Mechanics by H.Goldstein
2. Fundamentals of Classical Mechanics by J.C. Upadhyaya,
3. Classical Mechanics by Charles P.Poole, John Safko 3rd Edition, Parson Publications
4.Classical Mechanics by G. Aruldhas, PHI Publishers
5. Introduction to special relativity- Robert Resnick.

I Semester
Master of Science (Physics)
102PH24-INTRODUCTORY QUANTUM MECHANICS

Course Objectives:
- Introduction of Quantum Mechanics and the Schrodinger equation
- To acquire mathematical skills require to develop theory of quantum mechanics
- To develop understanding of postulates of quantum mechanics and to learn to apply them to solve some quantum mechanical systems
- To offer systematic methodology for the application of approximation methods to solve complicated quantum mechanical systems

UNIT-I (Schrodinger wave equation and one dimensional problem)
Why QM? Revision; Inadequacy of classical mechanics; Schrodinger equation; continuity equation; Ehrenfest theorem; admissible wave functions; Stationary states. One-dimensional problems, wells and barriers. Harmonic oscillator by Schrodinger equation.

Learning Outcomes:
- Students will learn the difference between classical mechanics and quantum mechanics.

UNIT-II (Linear vector spaces and operators)
Linear Vector Spaces in Quantum Mechanics: Vectors and operators, change of basis, Dirac's bra and ket notations. Eigen value problem for operators. The continuous spectrum. Application to wave mechanics in one dimension. Hermitian, unitary, projection operators. Positive operators. Change of orthonormal basis, Orthogonalization procedure, uncertainty relation.

Learning Outcomes:
- Students will learn the mathematical formalism of eigen values, eigen states of wells and barriers and unitary operators, hermitian operators, which form the fundamental basis of quantum theory.

UNIT III (Orbital angular momentum)
Angular momentum: commutation relations for angular momentum operator, Angular Momentum in spherical polar coordinates, Eigen value problem for L^2 and L_z, L_+ and L_- operators Eigen values and eigen functions of rigid rotator and Hydrogen atom

Learning Outcomes:
- Learn commutations relations for angular momentum operator and its applications in daily life
- Application to rigid rotator, hydrogen-like atoms and angular momentum operators will teach the students how to obtain eigen values and eigen states for such systems elegantly.

UNIT IV (Time-independent perturbation theory)
Time-independent perturbation theory; Non-degenerate and degenerate cases; applications to (a)normal helium atom (b) Stark effect in Hydrogen atom. Variation method. Application to ground state of Helium atom, WKB method.

Learning Outcomes:

- To understand the concepts of time-independent perturbation theory and their applications to physical situations.
- Studying the applications of Non-degenerate and degenerate cases in perturbation theory
- Learning the variation and WKB methods

UNIT V (Time dependent perturbation theory)

Time dependent perturbation: General perturbations, variation of constants, transition into closely spaced levels –Fermi's Golden rule. Einstein transition probabilities, Interaction of an atom with the electromagnetic radiation. Sudden and adiabatic approximation.

Learning Outcomes:

- Students will learn how to use perturbation theory to obtain corrections to energy eigen-states
  and eigen-values when an external electric or magnetic field is applied to a system
- Learning the significances of Fermi's Golden rule.
- To teach the students various approximation methods in quantum mechanics.

Course Outcomes:

- ➢ Understand historical aspects of development of quantum mechanics.
- ➢ Understand and explain the differences between classical and quantum mechanics.
- ➢ Understand the central concepts and principles in quantum mechanics, such as the Schrodinger equation, the wave function and its statistical interpretation, the uncertainty principle, stationary and non-stationary states, wells and barriers, harmonic oscillator, as well as the relation between quantum mechanics and linear algebra including understanding of linear vector spaces. They will master the concepts of angular momentum and spin, as well as the rules for quantization and addition of these. Hence they will be able to solve the complex systems by approximation method.

Text and Reference books

1. Eugen Merzbacher, Quantum Mechanics, Wiley
2. L I Schiff, Quantum Mechanics (Mc Graw-Hill)
3. B Crasemann and J D Powell, Quantum Mechanics (Addison Wesley)
4. A P Messiah, Quantum Mechanics
5. J J Sakural, Modem Quantum Mechanics
6. Mathews and Venkatesan Quantum Mechanics
7. Quantum Mechanics" by R.D. Ratna Raju
8. Fundamentals of quantum Mechanics, Statistical Mechanics & Solid State Physics by S.P.Kuila, Books and Allied, Kolkata

I Semester
Master of Science (Physics)
103PH24-MATHEMATICAL PHYSICS

Learning Objectives:

- Student should be able to understand basic theory of Complex Analysis, Special functions, Fourier series and integral transforms.
- To learn mathematical tools required to solve physical problem.
- To understand mathematical concepts related to physics
- To understand the relevance of higher mathematics and concepts of physics.

Unit-I

Beta & Gamma functions -definition, relation between them- properties.
Legendre's Differential equation: The Power series Solution–Legendre Functions of the first and second kind –Generating Function- Rodrigue's formula– Orthogonal Properties – Recurrence Relations-Physical applications.
Associated Legendre equation, Orthogonal properties of Associated Legendre's function.
Bessel's Differential Equation: Power series Solution –Bessel Functions of First and Second kind- Generating Function –Orthogonal Properties –Recurrence Relations-Physical applications.

Learning Outcomes:

- To learn about basic theory of polynomials
- To acquire knowledge about Legendre's, Associated Legendre's and Bessel equations.
- To learn the physical applications and properties in order to solve quantitative problems in the study of physics.

Unit-II

Hermite Differential Equation: Power series Solution–Hermite polynomials –Generating Function-Orthogonality –Recurrence relations -Rodrigues formula- Physical applications.
Laguerre Differential equations: The Power series Solution–Generating Function-Rodrigue's formula– Recurrence Relations, Orthogonal Properties- - Physical applications.

Learning Outcomes:

- To learn about basic theory of polynomials
- To acquire knowledge about Hermite Differential and Laguerre Differential Equation.
- To learn the physical applications and properties in order to solve quantitative problems in the study of physics.

Unit-III

Integral Transforms: Laplace transforms – definition- properties-Derivative of Laplace transform– Laplace transform of a derivative –Laplace transform of periodic function– evaluation of Laplace transforms–Inverse Laplace transforms-properties-evaluation of Inverse Laplace transforms– elementary function method– Partial fraction method– Solution of ordinary differential equation by using Laplace transformation method–Fourier series– evaluation of Fourier coefficients– problems–Fourier Transforms- infinite Fourier Transforms-Finite Fourier Transforms-Properties–problems.

Learning Outcomes:

- This will enable students to apply integral transform to solve mathematical problems and used to understand the analysis of Fourier series.
- The students will be able to use Fourier transforms as an aid for analyzing different types of waves.

Unit-IV

Complex Variables: Function of complex number- definition-properties, analytic function-Cauchy –Riemann conditions-polar form-problems, Cauchy's integral theorem, Cauchy's integral formula- problems, Taylor's Series-Laurent's expansion-Problems, Calculus of Residues, Cauchy's Residue theorem, Evaluation of Residues, Evaluation of contour integrals.

Learning Outcomes:

- To learn about complex algebra and Cauchy's integral theorems.
- To learn evaluation of contour integrals.

Unit-V

Tensor Analysis: Introduction– Contravariant, Covariant and mixed tensors – Rank of a tensor – symmetric and anti-symmetric tensors - Invariant tensors, Addition and multiplication of tensors, Outer and inner products- contraction of tensors and quotient law.

Learning Outcomes:

- The students should be able to formulate and express a physical law in terms of tensors.
- To know how to simplify tensors by using coordinate transforms.
- To understand what extent tensors used to explain theory of relativity.

Course Outcomes:

After successfully completing the course, student will be able to:

- Understand the basic elements of complex analysis, including the important integral theorems.
- Understand the applications special functions that are used in quantum mechanics.
- Learned how to expand a function in a Fourier series and able to solve mathematical problems relevant to the physical sciences.

Text and reference books:

1. Mathematical Methods for Physics. By G.Arfken
2. Laplace and Fourier Transforms-by Goyal and Gupta. PragatiPrakashan, Meerut
3. Matrices and Tensors for Physicists by A W.Joshi
4. Mathematical Physics byB.D.Gupta, Vikas Publishing House, New Delhi
5. Complex Variables, Schaum Series
6. Vector and Tensor Analysis, Schaum Series
7. Fundamentals of Mathematical Physics, 6th Edition by A.B.Gupta, Books and Allied, Kolkata.
8. Mathematical Physics - B.S. Rajput
9. Mathematical Physics - Satya Prakash

Semester 1
Master of Science (Physics)
104PH24--ANALOG AND DIGITAL ELECTRONICS

Course Objectives:

- Introduction of Semiconductor Devices and the Opto-electronic devices and their analysis.
- Operational Amplifiers, Construction and working DC and AC analysis, Effect of Feedback.
- Acquiring the Knowledge in Communication Electronics and then the Digital electronics.
- Architectureof8085Microprocessor, Instructionset,Addressingmodesandsomeillustrative programmes.
- Introduction to 8051 Microcontroller.

UNIT-I

Semiconductor Devices

Diodes, Junction diode, Tunnel diode, Photo diode, transistors, Silicon controlled rectifier, Uni junction transistor, Field effect transistor, JFET & MOSFET, CMOS,
Opto-electronic devices: Solar cells, Photo detectors, LEDs.

Learning Outcomes:

- ConstructionandworkingofTunneldiode,photodiode,SiliconControlledRectifier,Uni-junction Transistor.
- Know the Characteristics of FET, MOSFET and CMOS.
- Construction, working and applications of Solar Cells and LED's.

UNIT II

Operational Amplifiers

Differential Amplifier –circuit configurations - dual input, balanced output differential amplifier – DC analysis – Ac analysis, inverting and non inverting in puts CMRR. Block diagram of atypical Op-Amp-analysis .Open loop configuration inverting and non-inverting amplifiers. Op-amp with negative feedback-voltage series feedback– effect of feedback on closed loop gain input resistance output resistance bandwidth and output offset voltage- voltage follower.

Practical Op-amps

Input offset voltage- input bias current-input offset current, total output offset voltage, CMRR frequency response. Summing amplifier, Scaling and Averaging amplifiers, integrator and differentiator.
Oscillators principles, – oscillator types – frequency stability – responseThephaseshiftoscillator,Weinbridgeoscillator–Multivibrators- Monostable and a stable –comparators- Square wave and triangular wave generators- voltage regulators.

Learning Outcomes:

- To learn about the Differential amplifier and then the Operational amplifier, AC and DC analysis, Characteristics, Effect of Feedback.
- Oscillators Principles, Construction and working of different types of Oscillators. Clear picture of Multivibrators and then the Comparators using Operational amplifiers**.**

UNIT III

Communication Electronics

Amplitude modulation – Generation of AM waves – Demodulation of AM waves – DSBSC modulation. Generation of DSBSC waves. Coherent detection of DSBSC waves, SSB modulation, Generation and detection of SSB waves. Vestigial side band modulation, Frequency Division Multiplexing (FDM).

Learning Outcomes:

- Acquiring knowledge in Communication electronics AM &FM, modulation and Demodulation

UNIT IV

Digital Electronics

Simplification of Boolean expressions: Algebraic method, Karnaugh method, EX-OR, EX-NOR gates, Combinational Logic gates- Decoder- encoders- Multiplexer (data selectors)-application of multiplexer - De multiplexer(data distributors), Sequential Logic- Flip-Flops: A 1- bit memory – the R-S Flip – Flop, JK Flip-Flop – JK master slave Flip-Flop – T- Flip – Flop – D Flip – Flop – Shift registers – Synchronous and Asynchronous counters – cascade counters - A/D to D/A converters.

Learning Outcomes:

- Expressing the Boolean expressions in a simple way, Karnaugh method.
- Learning the Combinational Logic Circuits, Multiplexer and Demultiplexer
- Learning about the Sequential Logic circuits- Flip-Flops, Registers and Counters

UNIT V

Microprocessors

Introduction to microcomputers – memory – input/output –interfacing devices 8085 CPU -Architecture – BUS timings – Demultiplexing the address bus – generating control signals – instruction set – addressing modes – illustrative programmes – writing assembly language programmes –looping, counting and indexing – counters and timing delays – stack and subroutine. Introduction to micro controllers-8051 micro controllers-architecture & pin description.

Data interpretation and analysis-Precision and accuracy- Error analysis, propagation of errors. Least squares fitting.

Learning Outcomes:

- Knowledge about the Microprocessor and its Architecture
- Learning the Instruction Set, Addressing modes
- Writing the programmes using 8085 instructions
- Little knowledge about 8051 Microcontroller

Course Outcomes:

At the end of the course the student is expected to assimilate the following and possesses basic knowledge of the following.

- The design and functional performance of various semiconductor and optoelectronic devices such as Diodes, transistors, Solar Cells, Photo detectors and LEDs.
- To learn about the Differential amplifier and then the Operational amplifier, AC and DC Analysis, Characteristics, Effect of Feedback.
- Acquiring knowledge in Communication electronics AM &FM, modulation and Demodulation
- Learning the Combinational Logic Circuits, Multiplexer and Demultiplexer
- Learning about the Sequential Logic circuits- Flip-Flops, Registers and Counters
- Knowledge about the Microprocessor and its Architecture

Text and Reference Books

1. Electronic devices and circuits-G.K.Mithal(Khanna)
2. Integrated Electronics- Jacob millman & C.C. Halkies(TMH)
3. Op-Amps & Linear integrated circuits- Ramakanth A.Gayakwad
4. Op.Amps& Linear integrated circuits- D. Mahesh Kumar(MacMillan)
5. Digital principles and applications by A.P.Malvino and Donald P.Leech TMH 1993
6. Microprocess or Architecture, Programming and Applications with 8085/8086byRamesh S.Gaonkar, Wiely-Eastern 1987.
7. Digital Electronics: An Introduction to theory and Practical – William.H.Gotnman.

I Semester
M. Sc Physics
PRACTICAL – I
105PH24-General Physics and Optics

- Planks constant.
- Twin – T- Filter.
- Newton's Rings.
- Diffraction Grating – Normal incidence.
- Thermistor
- Mesh Method

I Semester
M. Sc Physics
PRACTICAL – II
106PH24-ELECTRONICS

- Single stage R-C coupled common emitter transistor amplifier.
- I-V characteristics of UJT.
- Astable multivibrator.
- Zener – Diode as voltage regulator.
- Relaxation oscillator.
- V-I characteristics of Light Dependent Resistor (LDR).
- RC-phase shift oscillator.

Semester 2
Master of Science (Physics)
Academic Year 2022-23 Amended
201PH24- STATISTICAL MECHANICS

Course Objectives:

- This course in statistical mechanics provides the basic idea of probability and calculating probability for various statistical systems of particles.
- To apply the principles of probability in distribution of particles in various systems
- To learn the different types of statistics distribution and particles.

UNIT I (Fundamentals of classical statistical mechanics)

Relation between statistical mechanics and thermodynamics, Phase space, Ensembles-micro canonical, canonical and grand canonical ensemble, density distribution in the phase space, Liouville's theorem, equipartition of energy theorem, microstates and macrostates.

Learning Outcomes:

- To learn postulates of classical statistical mechanics and Ensembles.
- To study density of states Liouville's theorem and paradox.

UNIT-II (Ideal gas in various ensembles)

Classical ideal gas in micro canonical ensemble, partition function for micro canonical ensemble, Gibb's paradox,

partition function for Canonical ensemble, thermo dynamical function for Canonical ensemble, partition function

for Grand canonical ensemble, thermodynamical function for Grand canonical ensemble.

Learning Outcomes:

- To know about partition function in different ensembles.
- To study the Gibb's paradox.

UNIT III (Energy fluctuation and distribution function)

Energy fluctuation in micro canonical ensemble, energy fluctuation in canonical ensemble, density fluctuation in Grand canonical ensemble, energy fluctuation in Grand canonical ensemble. Maxwell-Boltzmanndistribution, Bose-Einstein distribution**,** Fermi-Dirac distribution, Darwin-Fowler method.

Learning Outcomes:

- To study the features of Maxwell-Boltzmann statistics.
- To derive the Bose-Einstein distribution.

UNIT IV (Molecular partition function)

Molecular partition function- Translational partition function, Rotational partition function, Vibrational partition function, Electronic and Nuclear partition function, application of rotational partition function, application of vibrational partition function in solids.

Learning Outcomes:

- To learn electronic and nuclear partition function.
- To acquire knowledge about vibrational partition function in solids

UNIT V (Ideal Fermi and Bose Gas)

Equation of state of an ideal Fermi gas, theory of White dwarf stars, Landau diamagnetism, Photons, Phonons in solids, Bose-Einstein condensation, thermionic emission, magnetic susceptibility of free electrons, Brownian motion of a molecule.

Learning Outcomes:

- To learn about Ideal Fermi gas and to derive equations.
- To acquire knowledge about Bose- Einstein condensation.

Course Outcomes:

- After taking this course student are able to determine the probability of any type of events.
- Students have understood the concept of phase space and its volume.
- They can easily distinguish between different types of particles and statistics and can easily distribute bosons, fermions and classical particles among energy levels.
- After studying Fermi Dirac statistics, students have learnt to deal with much electron system.

Text and Reference Books:

1. Statistical and Thermal Physics by S. Lokanadhan and R.S. Gambhir (PHI).
2. Statistical Mechanics by K. Huang (Wiley Eastern)
3. Statistical Mechanics: Theory and applications by S.K. Sinha
4. Fundamentals of Statistical and Thermal Physics by F. Reif
5. Statistical Mechanics by Gupta and Kumar, Pragati Prakashan Pub. Meerut.
6.Statistical Mechanics by Satya Prakash.

Semester 2
Master of Science (Physics)
202PH24 SOLID STATE PHYSICS

Course Objectives:

- The present syllabus sequence of articles in each unit enables the student to understand the gradual development of the subject regarding solid state matter.
- Solid-state physics is provided an understanding of structure concerned with their association and regular, periodic arrangement in crystals.
- Understand the physics of insulators, semiconductor and conductors with special emphasis on the elementary band theory of semiconductors.

UNIT I
CRYSTAL STRUCTURE: Periodic array of atoms—Lattice translation vectors and lattices, symmetry operations, The Basis and the Crystal Structure, Primitive Lattice cell, Fundamental types of lattices—Two-Dimensional lattice types, three-Dimensional lattice types, Index system for crystal planes, Packing density: SC, BCC and FCC, simple crystal structures-- sodium chloride, cesium chloride, diamond structures and Zinc Sulfide.
Learning Outcomes:

- To understand the arrangement of atoms and the possible arrangements in solid state materials.
- To know about different parameters regarding the structure of the materials and crystal planes.
- Discussing structures of some familiar materials NaCl, CsCl, diamond and ZnS.

UNIT II
CRYSTAL DIFFRACTION AND RECIPROCAL LATTICE: Bragg's law, Experimental diffraction methods- Laue method and powder method, Derivation of scattered wave amplitude, Geometrical Structure Factor, Reciprocal lattice, Reciprocal lattice to SC lattice, BCC lattice and FCC Lattice, Propertiesof reciprocal lattice, Brillouin Zone, Neutron diffraction, Electron diffraction.
Learning Outcomes:

- Clear understanding of X-ray diffraction techniques like Laue, powder methods using Bragg's law.
- To know some useful parameters about cubic and non-cubic crystal systems.
- Understanding of positions of the atoms in a unit cell further useful to obtain knowledge on reciprocal lattice for different systems.

UNIT III
Lattice Vibrations and Thermal Properties: Elastic waves in one dimensional array of identical atoms. Vibrational modes of a diatomic linear lattice and dispersion relations. Acoustic and optical modes. Infrared absorption in ionic crystals. Phonons and verification of dispersion relation in crystal lattices. Lattice heat capacity– Einstein and Vibrational modes of continuous medium-Debye theory. Origin of thermal expansion and Gruneisen relation.
Learning Outcomes:

- To obtain expressions for one dimensional linear lattice and diatomic lattice.
- Distinguish between acoustical and optical modes.
- Understand the importance of Einstein's theory and Debye's theory.

UNIT IV

FREE ELECTRON FERMI GAS: Failures of free electron theory of metals (Qualitative only) Energy levels and density of orbits in one dimension, Free electron gas in 3 dimensions-Fermi-Dirac distribution function and variation of Fermi function with temperature (Qualitative only)-Density of states-Heat capacity of the electron gas, Experimental heat capacity of metals-Electrical conductivity and Ohm's law-Thermal conductivity of metals-Wiedemann-Franz law-Motion of magnetic field-Hall effect.

Learning Outcomes:

- Understanding the classical free electron theory - their failure and quantum free electron theory.
- Understanding about electrical and thermal conductivity.

UNIT V

THE BAND THEORY OF SOLIDS: Nearly free electron model, Origin of the energy gap, The Block Theorem, Kronig-Penny Model, wave equation of electron in a periodic potential, Approximate solution near a zone boundary, Effective mass of electron**,** The distinction between metals, insulators and semiconductors.

Learning Outcomes:

- Understanding the conduction, valance bands and reasons for energy band gap.
- Understanding about the band theory of solids and must be able to differentiate insulators, conductors and semiconductors.

Course Outcome:

- ➢ A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones.
- ➢ The students should be able to elucidate the important features of solid state physics by covering structural aspects like lattice cell parameters which are studied by diffraction techniques.
- ➢ A detailed understanding on band theory of solids helps to distinguish metals, insulators and semiconductors.

Text and Reference books:

1. Introduction to Solid State Physics, C. Kittel, 5th Edition,
2. Solid State Physics, A.J. Dekker.
3. Solid State Physics, S.O. Pillai 7th Edition
4. Solid State Physics H.C. Gupta, Vikas Publisher, Noida, 2nd Edition
5. Fundamentals of quantum Mechanics, Statistical Mechanics & Solid State Physics by S.P.Kuila, Books and Allied, Kolkata
6. Solid State Physics, M.A. Wahab, Narosa publishing house.

Semester 2
Master of Science (Physics)
203PH24-QUANTUM DYNAMICS AND SCATTERING THEORY

Course Objectives:

- Introduction of Spin and Total angular momentum
- To acquire mathematical skills require developing theory of different pictures.
- To develop understanding of scattering theory
- To offer systematic methodology for the application of molecular quantum mechanical systems

UNIT-I (Spin and Total angular momentum)

Introduction to spin and total angular momentum**,** spin angular momentum and Pauli's spin matrices, total angular momentum J. explicit matrices for $J^2, J_x, J_y \ \& \ J_z$, combination of two angular moment and tensor operator, Clebsch-Gordan coefficients for j_1=1/2, j_2 =1/2 and j_1=1, j_2 =1/2, Wigner-Eckart theorem.

Learning Outcomes:

- The students will be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.
- Students will learn the mathematical formalism of Clebsch-Gordan coefficients quantum theory.

UNIT II (Quantum dynamics)

Introduction to quantum dynamics**, e**quation of motion in Schrödinger picture and Heisenberg picture, correspondence between the two, correspondence with classical mechanics, application of Heisenberg picture to harmonic oscillator, interaction picture.

Learning Outcomes:

- Learn mathematical expressions for Schrödinger picture and their applications.
- Students will learn the application of Heisenberg picture.

UNIT III (Identical particles)

The indistinguishability of identical particles – the state vector space for a system of identical particles – creation and annihilation operators- continuous one particle system-dynamical variables – the quantum dynamics of identical particle systems.

Learning Outcomes:

- Students will learn the physical significance of identical particles.
- The students will be able to grasp the concepts of quantum dynamics of identical particle systems

UNIT IV (Scattering Theory)

Introduction of scattering – notion of cross section – scattering of a wave packet-scattering in continuous stream model – Green's function in scattering theory – Born approximation – first order approximation – criteria for the validity of Born approximation, form factor scattering- scattering from a square well potential – partial wave analysis – expansion of a plane wave – optimal theorem –scattering from a square well potential.

Learning Outcomes:

- Acquiring knowledge in sscattering theory
- Studying the applications of Green's function and Born approximation in Scattering Theory.

UNIT V (Molecular Quantum Mechanics)

Introduction to molecular quantum mechanics**,** the Born-Oppenheimer approximation – the hydrogen molecule ion – the valance bond method – the molecular orbital method- Comparison of the methods – Heitler-London method (Ref: Atkins, Chapter-9, 279-294).

Learning Outcomes:

- Students will gain theknowledge about the Born-Oppenheimer Approximation
- Learning the significances of Heitler-London method
- Knowing the importance of different methods involved in Molecular Quantum Mechanics

Course Outcomes:

- ➢ Understand the Spin, Total angular momentum and Clebsch-Gordan coefficients concepts.
- ➢ Understand historical aspects of identical particles in quantum mechanics
- ➢ Scattering theory will teach them how to use projectiles to infer details about target quantum system.

Text and Reference Books

1. Merzbacher, Quantum Mechanics
2. L I Schiff, Quantum Mechanics (Mc Graw-Hill)
3. B Crasemann and J D Powell, Quantum Mechanics (Addison Wesley)
4. A P Messiah, Quantum Mechanics
5. J J Sakural, Modem Quantum Mechanics
6. Mathews and Venkatesan Quantum Mechanics
7. Quantum Mechanics, R.D. Ratna Raju
8. Quantum mechanics by Kakani and Chandaliya
9. Atkins P, Molecular Quantum Mechanics, Oup 1996(T)

Semester 2
Master of Science (Physics)
104PH24-COMPUTATIONAL METHODS AND PROGRAMMING

Course objective:

- Finding the solutions for Linear and Non-linear equations and simultaneous equations
- Introduction to interpolations, numerical differentiation and integration
- The basics of C-language, C- character set, arithmetic expressions and some simple programs
- Acquiring knowledge about control statements, arrays and user defined functions
- Understanding the basic concepts of MATLAB and its applications

UNIT-ILinear, Nonlinear Equations and Simultaneous Equations
Linear and Nonlinear Equations: Solutions of Algebraic and transcendental equations-Bisection, False position and Newton-Raphson methods-Basic principles-Formulae-Algorithms **Simultaneous Equations:** Solutions of simultaneous linear equations - Gauss elimination method, Jacobi and Gauss Seidel iterative methods-Basic principles-Formulae-Algorithms

Learning outcomes:

- Learning the solutions to the linear equations , Algorithms
- Learning the solutions to the Non-linear equations, Algorithms
- Solutions to the simultaneous equations and Algorithms
- Learning Iterative methods for solutions and the Algorithms

UNIT-II Interpolations, Numerical differentiation and integration
Interpolations: Concept of linear interpolation-Finite differences-Forward, Backwards and central differences-Newton's and Lagrange's interpolation formulae-principles and Algorithms
Numerical differentiation and integration: Numerical differentiation-algorithm for evaluation of first order derivatives using formulae based on Taylor's series-Numerical integration-Trapezoidal and Simpson's 1/3 rule-Formulae-Algorithms, Solution of first order differential equation using Runge - Kutta method.
Learning outcomes:

- Learning various concepts of interpolations along with their principals and algorithms.
- Learning Taylor's series formulae and algorithm for evaluating first order derivatives
- Learning Trapezoidal and Simpson's 1/3 rule-Formulae, Algorithms for numerical integration.
- Learning Runge - Kutta method for solutions to first order differential equation

UNIT-III Fundamentals of C Language and Operators
Fundamentals of C Language:
C Character set -Identifiers and Keywords-Constants-Variables-Data types-Declarations of variables –Declaration of storage class-Defining symbolic constants –Assignment statement.
Operators - Arithmetic operators-Relational Operators-Logic Operators-Assignment

operators- Increment and decrement operators –Conditional operators- Bitwise operators. Arithmetic expressions – Precedence of arithmetic operators – Type converters in expressions – Mathematical (Library) functions – data input and output – The getchar and putchar functions-Scanf – Printf -simple programs.

Learning outcomes:

- Acquiring knowledge about C character set.
- Understanding different types of operators.
- Acquiring knowledge about arithmetic operators, mathematical functions, data input and output functions
- Writing the programmes using C character functions.

UNIT-IV Control statements, Arrays and User Defined functions

Control statements and Arrays: If-Else statements –Switch statement-The operator – GO TO –While, Do-While, FOR statements-BREAK and CONTINUE statements.

Arrays: One dimensional and two dimensional arrays –Initialization –Type declaration- Inputting and outputting of data for arrays –Programs of matrices addition, subtraction and multiplication

User Defined functions: The form of C functions –Return values and their types –calling a function – Category of functions. Nesting of functions- Recursion- ANSI C functions- Function declaration. Scope and life time of variables in functions.

Learning outcomes:

- Learning different types of control statements and arrays.
- Little knowledge about Initialization, Type declaration, Inputting and outputting of data for arrays.
- Acquiring knowledge on various user defined functions.
- Learning about function declarations and lifetime of variables in functions.

UNIT V-MATLAB and Applications:

Basics of Mat lab- Mat lab windows – On-line help- Input-Output-File types-Platform Dependence-Creating and working with Arrays of Numbers – Creating, saving, plots printing Matrices and Vectors – Input – Indexing – matrix Manipulation-Creating Vectors Matrix and Array Operations Arithmetic operations-Relational operations – Logical Operations – Elementary math functions, Matrix functions – Character Strings Applications- Linear Algebra,-solving a linear system, Gaussian elimination, Finding Eigen values and eigenvectors, Matrix factorizations, Curve Fitting and Interpolation – Polynomial curve fitting on the fly, Least squares curve fitting, General nonlinear fits, Interpolations.

Learning outcome:

- Learning basic knowledge of MATLAB
- Understanding various operations and functions in MATLAB
- Acquiring knowledge about curve fittings using MATLAB

Course outcome:

At the end of the course the student is expected to assimilate the following and possesses basic knowledge of the following.

- The principals and algorithms of various concepts of interpolation, numerical differentiation and integration
- The C character set, arithmetic operators, mathematical functions, data input and output functions, Program writing using C character functions

- To write programs of matrices addition, subtraction and multiplication using arrays
- Application of MATLAB

Text and Reference Books

1. Numerical methods, V.N.Vedamurthy, N.Ch.S.N.Iyengar, FirstEdition(VPH)
2. Computer Oriented Numerical Methods-V. Raja Raman-fourth edition(PHI)
3. Y. Kirani Singh and B. B.Chaudhuri, MATLAB Programming, Prentice-Hall India, 2007
4. Rudra Pratap, Getting Started with Matlab 7, Oxford, Indian University Edition, 2006
5. Stormy Attaway: A Practical introduction to programming and problem solving, Elsevier 2012
6. Numerical Methods, E. Balaguruswamy, Tata McGraw Hill

Semester 3
Master of Science (Physics)
301PH24-NUCLEAR AND PARTICLE PHYSICS

Course Objectives:

- Utilizing the basic concepts of Nuclear and Particle physics, the forces, models and decay theory Nucleus of lattice.
- Elementary particle physics and applications of Nuclear physics would be extensively discussed in this course.
- The detailed theory of accelerators
- The primary objective is to teach the concepts of Nuclear and particle physical and important applications in nuclear physics.

UNIT-I (Nuclear Forces)

Mass defect, Binding energy, nuclear magnetic dipole moment, electric quadrupole moment, characteristics of Nuclear Forces, ground state of deuteron, qualitative discussion of neutron-proton scattering at low energies, proton- proton scattering at low energies, saturation of nuclear forces, Meson theory of nuclear forces(Yukawa's Potential).

Learning Outcomes:

To study the primary concepts in Nuclear physics and domains, instability, Energy levels, mirror nuclei.

- Characteristics of Nuclear Force and Ground state of deuteron.
- Discussions onscattering cross-sections, neutron-proton and proton- proton scattering at low energies.
- Knowledge about charge independence, spin dependence of nuclear forces.
- Meson theory of nuclear forces.

UNIT-II (Nuclear Models and Nuclear Decay)

Weizsacker semi-empirical mass formula, Liquid drop model, Bohr –Wheeler theory of nuclear fission, Nuclear shell model-square well of infinite depth, harmonic oscillator potential, spin-orbit potential. Gamow's theory of Alpha decay process, Fermi's theory of β - decay.

Learning Outcomes:

- Complete knowledge on concepts in Nuclear Models**.**
- Alpha decay process, Energy release in Beta-decay, Fermi's theory of β - decay, selection rules and parity violation in β -decay.

UNIT-III (Nuclear Reactions and Nuclear Energy)

Types of nuclear reactions, conservation laws of nuclear reactions, Nuclear reaction kinematics - the Q – equation, threshold energy- Nuclear cross section.

Nuclear fission, types of fission, nuclear fusion and thermonuclear reactions, general aspect of reactor design, classification of reactors-research reactors and power reactors.

Learning Outcomes:

- Knowledge on various kinds of nuclear reactions and conservation laws.
- Detailed information on nuclear kinematics, the Q – equation, threshold energy.
- Explanations on various concepts of nuclear Fission.
- Types of nuclear reactors and subject on nuclear chain reaction.

UNIT-IV (Particle Accelerators)

Introduction, Classification of accelerators, Electrostatic accelerators – Cockcroft-Walton accelerator, Van de Graff accelerator, Linear accelerators – Drift tube accelerators , Wave guide accelerators – Low energy circular accelerators – Cyclotron (fixed frequency)and Betatron accelerator.

Learning Outcomes:

- Knowledge on Classification of accelerators.
- Types of Linear accelerators and Low energy circular accelerators.

UNIT-V (Elementary Particle Physics)

Classification of elementary particles, particle interactions, conservation laws (linear momentum, angular momentum, energy, charge, baryon number, lepton number, isospin, hyper charge, strangeness quantum number), Elementary ideas of CP and CPT invariance, SU(2), SU(3) multiplets, Quark model.

Learning Outcomes:

- Classification - Particle interactions and families, symmetries and conservation laws
- Elementary ideas of CP and CPT invariance, SU(2), SU(3) multiplets and Quark model.
- Knowledge on dissimilar applications in nuclear physics.

Course Outcomes:

- Describe and understand the differential nuclear reactions and nuclear forces.
- Understand the applications of nuclear physics.
- Students have understood the concept of nuclear fission and nuclear fusion.

Text and Reference books

1. Nuclear Physics by D.C. Tayal, Himalaya publishing Co.,
2. Introductory Nuclear Physics by Kenneth S. Krane
3. Introduction to Nuclear Physics by Harald A. Enge
4. Concepts of Nuclear Physics by Bernard L. Cohen.
5. Elementary particle physics- M.J. Longo
6. Introduction to Elementary Particles by D. Griffiths
7. Nuclear Physics by S.B. Patel, Wiley Eastern Ltd.,

NOTE: Question paper contains **FIVE** questions with internal choice have to be set from each unit. Each question carries 14 marks.

Semester 3
Master of Science (Physics)
302PH24- ADVANCED QUANTUM MECHANICS

Course Objectives:

- Understanding of relativistic quantum mechanics with different aspects in the presence of electromagnetic fields
- Representation Dirac equation, different notations for covariance and invariance under Lorentz transformations, getting knowledge on charge conjugation
- Introduction on field quantization and effect of quantization on different fields, second quantization.

Unit – I (Klein –Gordon and Dirac equation)

Klein –Gordon equation –continuity equation (probability and Current density) - Klein – Gordon equation in presence of electromagnetic field – Dirac equation (for a free particle) - probability and Current density – constants of motion - Dirac equation in presence of electromagnetic fields

Learning Outcomes

- Derivation of Klein –Gordon equation for a free particle and in the presence of electromagnetic fields
- Variation of Dirac equationin case of a free particle and electromagnetic field.
- Continuity equation in the absence (free particle) and presence of e.m.field

Unit – II (Applications of Dirac's equation)

Hydrogen atom – covariant notation – covariance of Dirac equation- invariance of Dirac equation under Lorenz transformation – pure rotation and Lorentz transformation. Charge conjugation – hole theory and charge conjugation – projection operators for energy and spin- bilinear covariant – Dirac equation for zero mass and spin ½ particles.

Learning Outcomes

- To learn about Hydrogen atom under the quantum effects and Dirac equation,
- Knowing information on Lorentz transformation, charge conjugation

Unit – III (Quantization of classical field)

Introduction for quantization of fields – concept of field Hamiltonian formulation of classical field – real scalar field Schrodinger field – Dirac field – Maxwell's field – quantum equation of the field – quantization of real scalar field and second quantization – quantization of complex scalar field – quantization of Schrödinger field - quantization of Dirac field.

Learning Outcomes

- Basic concepts of quantization of fields, derivation and problematic approaches to Dirac and Maxwell's fields.
- Concept of Second quantization and scalar fields.

Unit – IV (Quantum theory of radiation)

Classical radiation field, creation, annihilation and number operators, quantized radiation field. Emission and absorption of photons by atoms, Rayleigh scattering, Thomson scattering, and the Raman effect, radiation damping and resonance fluorescence, dispersion relations and causality, the self-energy of a bound electron: the Lamb shift.

Learning Outcomes

- Students should be able to understand radiation fields representation in semi classical approaches.
- To know the representation and analysis of the self-energy of a bound electron.
- To understand the various scattering methods such as Thomson Scatterings.

Unit – V (Relativistic quantum mechanics)

Probability conservation in relativistic quantum mechanics,the Dirac equation, simple solutions, non relativistic approximation, plane waves. Relativistic covariant, bilinear covariants, Dirac operators in the Heisenberg representation, Zitterbewegung and negative-energy solutions, central force problem., the hydrogen atom, hole theory and charge conjugation, quantization of the Dirac filed, weak interaction and parity non conservation., the two-component neutrino.

Learning Outcomes

- Students should be able to understand Relativistic covariant
- To know the representation and analysis of Zitterbewegung solutions
- To understand the Dirac filed.

Course Outcomes

- ➢ Relativistic quantum mechanics will provide an exposure to how special relativity in quantum theory works on free particles and in the electromagnetic field.
- ➢ The basics of scattering theory are understood.

Text and Reference books

1. Advanced Quantum Mechanics by J.J. Sakurai
2. Relativistic Quantum Fields. Vols. I & II byBjorken and Drell
3. Quantum Field Theory by Mandl
4. Particles and Fields by Lurie
5. Quantum Theory of Fields. Vols. I & II by Weinberg

Semester 3
Master of Science (Physics)
303PH24- CONDENSED MATTER PHYSICS -I

Course Objectives:

- Utilizing the basic concepts of solid state physics, the quantum theory of lattice dynamics and thermal neutron scattering would be extensively discussed in this course.
- Properties of metallic lattices, simple alloys and estimation of concentration of defects in ionic crystals.
- The ultraviolet spectrum of the alkali halides, excitons, Illustration of electron-hole interaction in single ionsand Lattice defect in ionic crystals and estimation of concentration of defects in ionic crystals. Thallium-activated alkali halides, The sulfide phosphors, Electroluminescence.
- Vibrational modes of a diatomic linear lattice and dispersion relations and Lattice thermal conductivity- Phonon mean free path.
- Quantum theory of Para magnetism, Crystal Field Splitting, Quenching of the orbital Angular Momentum.
- Saturation Magnetization at Absolute Zero and Magnons, Bloch's $T^{3/2}$ law.

UNIT-I

Defects: Properties of metallic lattices and simple alloys: The structure of metals –classification of lattice defects. Configurational -entropy –The number of vacancies and interstitial as function of temperature –The formation of lattice defects in metals. Lattice defect in ionic crystals and estimation of concentration of defects in ionic crystals. Edge and screw dislocation The Frank read mechanism of dislocation multiplication.

Learning Outcomes:

- Properties, structure and classification of metal alloys and their defects.
- Estimation of lattice defects in ionic crystals.
- To know how to form lattice defects in metals.
- To learn about the Frank read mechanism of dislocation multiplication.

UNIT-II

Optical Properties: Optical and thermal electronic excitation in ionic crystals, The ultraviolet spectrum of the alkali halides; excitons, Illustration of electron-hole interaction in single ions, Qualitative discussion of the influence of lattice defects on the electronic levels, Non stoichiometric crystals containing excess metal, The transformation of F centers into F_1 centers and vice versa, Coagulation of F centers and colloids, Color centers resulting from excess halogen, Color centers produced by irradiation with X-rays.

Learning Outcomes:

- Optical and thermal electronic excitation of ionic crystals and Illustrate the electron-hole interaction in single ions.
- The transformation of F centers into F_1 centers and learn about Photoconductivity in crystals containing excess metal.
- General remarks about Luminescence Excitation and emission, Decay mechanisms.
- To know about Thallium-activated alkali halides, sulfide phosphors and Electroluminescence.
- Learning the Non stoichiometric crystals containing excess metals.

UNIT-III Photoconductivity and Luminescence

Excitons: Weakly bound and tightly bound – Photoconductivity – Simple model – Influence of traps – Space charge effects – Determination of photoconductivity. Luminescence – Various types– Thermoluminescence, Electroluminescence, Photoluminescence, Cathodoluminescence and Chemiluminescence - Excitation and emission – Decay mechanisms – Applications.

Learning Outcomes:

- To know about photoconductivity and various traps and their effects.
- General remarks about Luminescence Excitation and emission, Decay mechanisms.
- Learning the applications of decay mechanisms..

UNIT IV: Semiconductor Physics

Intrinsic and extrinsic semiconductors –Fermi level, Expressions for electron and hole concentrations in intrinsic and extrinsic semiconductors– Variation of Fermi level with temperature – np product – Carrier mobility, conductivity and their variation with temperature – Direct and indirect band gap semiconductors – Differences and examples – Continuity equation – Drift and Diffusion – Einstein relation –Recombination of electron -hole pairs - various recombination mechanisms.

.**Learning Outcomes:**

- Knowledge about the importance of semiconductors.
- To know about the variation of Fermi level with temperature.
- To know about the direct and indirect band gap semiconductors
- Learning with various recombination mechanisms.

UNIT V

Magnetic Properties of Solids: Quantum theory of Para magnetism, Crystal Field Splitting, Quenching of the orbital Angular Momentum, Ferromagnetism Curie point and the Exchange integral, Saturation Magnetization at Absolute Zero, Magnons, Bloch's $T^{3/2}$ law. Ferromagnetic Domains. Antiferromagnetism, The two-sublattice model, Superexchage interaction Ferrimagnetism, The structure of ferrites, The saturation magnetization, Elements of Neel's theory. (Solid State Physics by C. Kittel Chapters 14 and 15)

Learning Outcomes:

- Ferromagnetism Curie point and the Exchange integral, Saturation Magnetization at Absolute Zero,
- To learn about the Ferromagnetic Domains. Antiferromagnetism,
- To study the saturation magnetization and Elements of Neel's theory.

Course Outcomes:

- A student of this course is expected to understand thoroughly the concepts of lattice dynamics and Luminescence Excitation and emission, Decay mechanisms spectroscopy.
- In addition, the students would be able to perform various analytical as well as numerical calculations needed for understanding the quantum theory of solids.

Text and Reference Books

1. Madelng: Introduction to Solid State theory
2. Callaway: Quantum theory of solid state
3. A.J. Dekker: Solid state physics
4. C. Kittel: Solid State Physics
5. Introduction to Semiconductor materials and devices –MS .Tyagi , Wiley
6. Solid State Physics S.O. Pillai New Age International

Semester 3

Master of Science (Physics)

304PH24-CONDENSED MATTER PHYSICS -II

Course Objectives:

- Continuation to Condensed Matter Physics-I for depth of the core subject.
- Initiation of theoretical conceptual ideas about elementary mechanics of molecules.
- Energy level representation through different conceptual and pictorial representations.
- Adoption of mixture of concepts from statically mechanics, classical mechanics and quantum mechanics for Dielectric studies.
- Expansion of those concepts for ferroelectrics.

UNIT- I

Elements of group theory: Introduction to crystallographic point groups, the five platonic solids, procedure for symmetry classification of molecules, class, matrix notation for geometrical transformations, matrix representation of point groups, reducible and irreducible representations, great orthogonality theorem and its consequences, Character tables for C_{2V} and C_{3V} point groups, Mullikan symbolism, Symmetry species.

Learning Outcomes:

- Learning concepts of mechanics crystallography via point groups
- Study the classification of point groups and matrix and notation representations.
- In view of Competitive exams problematic and derivational tactics through characteristics tables and symmetry species.

Unit II

Elements of Ligand field theory& Electronic spectra: Concept of ligand field and crystal field. Free ion configurations- terms and states. Derivation of free ion terms for d^1 and d^2 configuration. Energy ordering of terms- Hund's rules.

Learning Outcomes:

- Learning theories of Elements of Ligand field theory & Electronic spectra with ligand field and crystal field.

Unit III Crystal fields parameters

Strength of crystal fields, Crystal field potentials for O_h and T_d fields. Meaning of Dq. Construction of ligand field energy level diagrams- effect of weak crystal fields on terms. Splitting due to lower symmetries Electronic spectra of d^1 and d^9 systems.T-S Diagrams with specific examples.

Learning Outcomes:

- Creating interest toward research via theory, calculation and pictorial presentation T-S diagrams and crystal field theory.

Unit-IV

Dielectrics: Macroscopic description of the static dielectric constant, The static electronic and ionic polarizabilities of molecules, Orientational Polarization, The static dielectric constant of gases. The internal field according to Lorentz, The static dielectric constant of solids, Classius-Mosetti equation, The complex dielectric constant and dielectric losses, Dielectric losses, relaxation time and Debye's relations, Cole-Cole diagrams. The classical theory of electronic polarization and optical absorption.

Learning Outcomes:

- Learning concepts of Dielectrics and polarization

- Study the fields through Lorentz field and pictorial representation to understand Cole-Cole diagrams.

Unit V

Ferroelectrics: General properties of ferroelectric materials. Classification and properties of representative ferroelectrics, the dipole theory of ferroelectricity, objections against the dipole theory, Ionic displacements and the behaviour of $BaTiO_3$ above the curie temperature, the theory of spontaneous polarization of $BaTiO_3$. Thermodynamics of ferroelectric transitions, Ferroelectric domains.

Learning Outcomes:

- Learning concepts of ferroelectric materials.
- Creating interest toward research via theory and thermodynamics of ferro electric transitions.

Course Outcomes:

- Students will get knowledge on Elements of group theory and point groups.
- Students will be able to do Crystal field theory, crystal field potentials and T-S diagrams.
- Students will know what a polarization and Clasius- Mosseti equation is.
- Understating of Ferroelectrics and theories, classifications and domains can also be done.

Text and Reference Books

1. Chemical applications of group theory by F.A. Cotton
2. Spectroscopy of molecules by Veera Reddy
3. Solid State Physics by A.J.Dekker (Macmillan)
4. Solid State Physics by C.Kittel
5. Advanced inorganic chemistry by F.A. Cotton & G. Wilkinso

Semester 3
M. Sc Physics
PRACTICAL – I
305PH24-MICROPROCESSOR & C PROGRAMMING

- Multiplication by repetitive addition
- Multibyte addition.
- Decoding the number in ASCII.
- Interchanging the digits in a two digit number.
- Addition of two matrices.
- Surface Area, volume of sphere and cone.
- Trace of a matrix
- Distance between the two points.
- Given number is a prime or not.
- Transpose of a given matrix.

Semester 3
M. Sc Physics
PRACTICAL – II
306PH24-CONDENSED MATTER PHYSICS

- Specific heat of Graphite.
- IV characteristics of solar cells.
- Internal series Resistance of Solar cells.
- Dielectric constant of Ferro electric material.
- Series and parallel combination of solar cell.
- Coefficient of thermal expansion.

Semester 4
Master of Science (Physics)
401PH24-ELECTROMAGNETIC THEORY, LASERS AND MODERN OPTICS

Course Objectives:

- Introduction to Electromagnetic waves
- To gain mathematical skills to develop theory of Electromagnetic laws
- To understanding of concept of basic laws in wave propagation
- To analyse the waves and antennas for signal propagation
- To understand the importance of lasers in diversified fields.
- To analyse various optical devices for day to day life
- To understand linear optics and non-linear optical devices

UNIT–I Electromagnetic Waves

Electromagnetic Theory: Maxwell's equations –General wave equation-Propagation of light in isotropic dielectric medium–Propagation of light in conducting medium –Skin depth –Laws of reflection and refraction at the boundary of a dielectric interface–Fresenel's equations–Poynting's theorem–Non-Uniqueness' of electromagnetic potentials and Gauge transformations (Coulomb and Lorentz gauge).

Learning Outcomes:

- The students will be able to grasp the concepts of electro magnetic theory, as well as its aims.
- Students will learn concepts of radiation, potentials, signal, and propagation of electromagnetic waves in media.
- Students will acquire the knowledge on different types of equations derived from Maxwell's equations.

UNIT–II Electromagnetic Radiation

Electromagnetic Radiation –Retarded Potentials –Radiation from an Oscillating dipole –Electric quadrupole– radiation-Linear Antenna –Lienard-Wiechert Potentials–Electromagnetic fields of a uniformly moving point charge-Radiation from an accelerated charge at low velocity-Larmor's formula.

Learning Outcomes:

- The students will be able to grasp the production of electro magnetic radiation from different accelerated charges, as well as its aims.
- Students will learn concepts of potentials, signal , Antenna theory.

UNIT-III Lasers

Lasers: Introduction – directionality- brightness- monochromaticity- coherence – relation between the coherence of the field and the size of the source – The Einstein coefficients – Population inversion-Pumping schemes – attainment of population inversion - two level – three level and four level pumping . Optical feedback: the optical resonator-Quality factor– laser power and threshold condition confinement of beam within the resonator.- line broadening mechanisms – natural, collision and Doppler broadening–Types of Lasers:, He-Ne Laser, Semiconductor GaAs laser, CO_2 Laser, Nd-YAG Laser– applications of lasers.

Learning Outcomes:

- Learn the principles behind working of laser

- Students will learn the importance of absorption and emission processes in lasers.
- Students will acquire the knowledge about applications of lasers in different fields

UNIT –IV Non linear Optics and Holography

Basic Principles- Harmonic generation – Second harmonic generation–Phase matching – Third Harmonic generation-Optical mixing –Parametric generation of light –Parametric light oscillator– Frequency up conversion–Self focusing of light-Introduction to Holography– Recording and reconstruction of Hologram–Basic theory of Holography– Diffuse object illumination-Speckle pattern –-Applications of Holography.

Learning Outcomes:

- Acquiring knowledge on Non linear optical devices and Holographic materials
- Students will acquire mathematical skills require to develop the harmonic generation
- Students will acquire the knowledge importance of hologram after invention of lasers
- Students will understand recording of hologram by basic laws

UNIT–V Fiber Optics

Introduction – total internal refraction –optical fiber modes and configurations– fiber types – Step index fiber structures – single mode fibers-Graded index fiber structure – Fiber materials and fabrication– Wave guide equation– wave equations for step indexed fibers – modal equation – attenuation – Signal distortion on optical wave guides – Block diagram of fiber optic communication system – Applications of optical fibers.

Learning Outcomes:

- Students will learn the principle of optical fiber for communication
- Learning the physical significances of different types of fibers
- Knowing the Preparation of different techniques used for making optical fibers

Course Outcomes:

- At the completion of this course students will be able to
- Understand application of lasers in day to day life
- Understand communication of signals from one point to other
- Student will understand the information on common basics involved in the non-linear optics and fibre optics
- Acquire knowledge various scientific phenomena and their relevance in day to day life
- Teacher will teach the importance of Electromagnetic theory and Modern Optics

Text and Reference Books

1. Introduction to Electrodynamics by D.J.Griffiths, Prentice-Hall, India
2. Electromagnetics by B.B. Laud, Wiley –Eastern, New Delhi.
3. Modern Optics by Fowels
4. Laser and their applications by M.J. Beesly, Taylor and Francis, 1976.
5. Laser and Non-Linear Optics by B.B. Laud, Wiley Eastern Ltd.,1983.
6. Optics by E. Hecht, Addison Wiley, 1974.
7. Optical fibers communications by Gerel Keiser, McGraw Hill Book, 2000.

Semester 4

Master of Science (Physics)

402PH24- ATOMIC, MOLECULAR AND RESONANCE SPECTROSCOPY

Learning Objectives:

- The subject of Molecular and Solid State Spectroscopy has reached a significant advancement in high–precision experimental measurement techniques.
- The main objective is to teach the students the basic atomic and molecular (diatomic) structures with quantum mechanical approach leading to their fundamental spectroscopies.

UNIT I: Atomic Absorption Spectroscopy

Introduction – Principle – Differences between Atomic Absorption Spectroscopy and Flame Emission Spectroscopy– Advantages of Atomic Absorption Spectroscopy over Flame Emission Spectroscopy–Disadvantages of Atomic Absorption Spectroscopy–Applications of Atomic Absorption Spectroscopy.

Learning Outcomes:

- To know about atomic structure and how they absorb the energy.
- To learn about different absorption techniques.

Unit-II: Absorption spectrophotometer

Introduction-Beer's law-Absorptivity-UV and Visible absorption-Instrumentation-Block diagram of spectrophotometer-gratings and prisms-radient energy sources-filters-photosensitive detectors-barrier layer cells-photo emissive cells-photomultiplier tubes. Relation between absorption in the visible and UV region and molecular structure.

Learning Outcomes:

- To know about absorption techniques.
- To acquire knowledge about absorption process and instrumentation.

Unit-III: Raman spectroscopy- Introduction-Theory of Raman scattering-Rotational Raman spectra-Vibrational Raman Spectra-Laser Raman Spectroscopy – Sample Handling techniques-Polarisation of Raman Scattered light-Fourier Transform (FT) Raman Spectroscopy and its additional advantages over the conventional Raman Spectroscopy.

FTIR spectrometer-Principle-working-block diagram-molecular structure-qualitative and quantitative analysis-applications-difference between FTIR and IR spectrometer.

Learning Outcomes:

- To learn about the molecular spectroscopy and its techniques.
- To know about the instrumentation of FTIR.

UNIT-IV

NMR Theory, Basic Principles, Nuclear spin and Magnetic moment, Relaxation mechanism, spin lattice and spin-spin relaxation (12) times by pulse methods, Bloch's equations and solutions of Bloch's equations – Experimental methods, CW NMR Spectrometer. Electron Spin Resonance – The ESR spectrometer, experimental methods, thermal equilibrium and Relaxation methods, characteristics of g and A values, Unpaired electron, fine structure and Hyperfine structure.

Learning Outcomes:

- To learn the Basic principles of NMR theory and Experimental methods.
- To study what is ESR and ESR spectrometer.

UNIT-V

Nuclear quadrupole resonance (NQR) spectroscopy, The fundamental requirements of NQR spectroscopy, General principles, Integral spins and Half Integral Spin., experimental detection of NQR frequencies, block diagram of NQR spectrometer, Experimental methods of SR oscillator, CW oscillator, pulse methods. Mossbauer spectroscopy: The Mossbauer Effect, Recoil less Emission and Absorption, The Mossbauer spectrometer, Experimental Methods, Chemical shift, Magnetic Hyperfine interactions. Photo Electron Spectroscopy, its theory, instrumentation and Applications.

Learning Outcomes:

- To know about NQR and experimental detection of NQ frequencies.
- To study Mossbauer spectroscopy.
- To learn Photo electron spectroscopy and its applications.

Course Outcomes:

After the completion of the course, students will be able to:

- Describe theories explaining the structure of atoms and the origin of the observed spectra.
- Knows the different types of atomic spectra.
- Explain the observed dependence of molecular, atomic and electron spectral lines on externally applied electric and magnetic fields.
- The student would be equipped with an in-depth knowledge of spectroscopic techniques that can be applied in solving problems.

Text and Reference Books:

1. Atomic and Molecular Spectroscopy, Gurdeep Chatwal, Sharma Anand, Himalaya Publishing House.
2. Fundamentals of Molecular Spectroscopy, C.N. Banwell, Tata Mc Graw-Hill,1983.
3. Instrumental methods of Analysis by Willard, Merritt and Dean
4. Molecular spectra and Molecular Structure (van Nostrand) by G. Herzberg
5. Introduction to atomic spectra by H.E. White (T)
6. Fundamentals of molecular spectroscopy by C.B. Banwell (T)
7. Nuclear Magnetic Resonance By E.R. Andrew, Cambridge University Press 1955
8. Spectroscopy by B.P. Stranghon and S.Walker Volume -1 John Wiley and Sons Inc., New York, 1976
9. Pulse and Fourier transform NMR by TC farrar and ED Becker, Academic Press 1971
10. Mossbauer Spectroscopy by M.B. Bhide.

Semester 4
Master of Science (Physics)
403PH24- ADVANCES IN MATERIALS SCIENCE

Course Objective:

- Acquiring the knowledge on material types and then introduction to glasses, glass forming systems, glass transition temperatures and applications of glasses
- Introduction to liquid crystals
- To acquire knowledge on hexagonal, cubic and lamellar phases of amphiphilic molecular systems
- Obtain fundamental concepts and current knowledge of biomaterials and their biomedical applications
- To demonstrate nanocrystalline materials types and their properties and also to understand various approaches of nanomaterial synthesis and characterization

Unit-I

Introduction: Classification of Materials: Types of materials, Metals, Ceramics (glasses), polymers, composites, semiconductors.

Glasses: The glass transition - theories for the glass transition, Factors that determine the glass-transition temperature. Glass forming systems and ease of glass formation, preparation of glass materials.

Applications of Glasses: electronic applications, electrochemical applications, optical applications, magnetic applications.

Learning outcomes:

- Classification of materials
- The basic knowledge about glass, glass preparation, characteristics of glass formation, factors of glass transition, applications of Glasses

Unit-II

Biomaterials: Implant materials: Stainless steels and its alloys, Ti and Ti based alloys, Ceramic implant materials; Hydroxyapatite glass ceramics, Carbon Implant materials, Polymeric Implant materials, Soft tissue replacement implants, Sutures, Surgical tapes and adhesives, heart valve implants, Artificial organs, Hard Tissue replacement Implants, Internal Fracture Fixation Devices, Wires, Pins, and Screws, Fracture Plates.

Learning outcomes:

- The fundamentals of biomaterials
- To acquire knowledge about types of implant materials and their biomedical usage

Unit-III

Liquid Crystals: Mesomorphism of anisotropic systems, different liquid crystalline phases and phase transitions, Elastic continuum theory of liquid crystals, liquid crystals in electric and magnetic fields, few applications of liquid crystals.

Learning outcomes:

- To learn about types of liquid crystals and theory of liquid crystals
- To acquire knowledge about defects and dynamics in liquid crystals

Unit-IV: Nanomaterials:

Origin of Nano materials-Zero, one and two dimensional Nano materials quantum confinement, density of states, physical and chemical properties, synthesis of Nano materials-Bottom-up and Top-down approaches, Chemical methods: Sol-Gel process-Spray Pyrolysis- Solvothermal synthesis-Chemical vapor deposition (CVD), Physical methods: Ball milling-Inert gas condensation technique-Thermal evaporation-Pulsed Laser Deposition (PLD)-Sputtering-Laser ablation method.

Learning outcomes:

- To understand various types of nano crystalline materials
- To describe several synthesis methods for fabrication of nanomaterials
- To analyze and characterize the properties of nanomaterials using various characterization techniques
-

Unit-V: **Carbon based nanomaterials:**

Carbon based molecules and carbon bond - C60: Discovery, Synthesis and structure of C60 - Superconductivity in C60 - Carbon nanotubes: Fabrication – Structure – Electrical properties – Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors, catalysts).

Learning outcomes:

- To understand various types of Carbon nanotubes.
- To describe electrical properties
- Applications of nanomaterials

Course Outcome:

At the end of the course the student is expected to assimilate the following and possesses basic knowledge of the following.

- ➢ The fundamental knowledge about material classification, glass, glass preparation, characteristics of glass formation, factors of glass transition, applications of Glasses
- ➢ The knowledge about types of biomaterials used in various implants

Text and Reference Books:

1. Inorganic solids D. M. Adams (John-Wiley)
2. Physics of Amorphous Materials by S.R. Elliott.
3. Fundamentals of thermotropic liquid crystals, deJen and Vertoghen
4. Nanocrystalline materials- H. Gleiter
5. Biomaterials Science and Engg. J.B. Park
6. Intro.duction to Material science for Engineers by James. F. Shackelford (Newyork. 1985)
7. Charles P Poole Jr., Frank J. Ownes, Introduction to Nanotechnology, John Wiley Sons,
8. Science of Engineering Materials and Carbon Nanotubes, C.M. SRIVASTAVA and C. SRINIVASAN (New AgeInt).

Semester 4

Master of Science (Physics)

Commented [D1]:

404PH24 - ADVANCED CONDENSED MATTER PHYSICS

Course Objective:

- The lattice dynamics of the solids are discussed briefly to understand the influence of interatomic forces on crystals of different bonding nature and studied thermal properties of the solids including the interaction of electron, photon and phonons.
- Understanding of the crystal growth techniques with different states of the matter.
- Interaction of the electrons with phonons and polaron.
- Properties and practical applications of superconductors.

UNIT I

Lattice Dynamics and Optical properties of Solids: Inter atomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Optical phonons and dielectric constants. Inelastic neutron scattering. Anhormonicity, thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons., Direct and indirect transitions.

Learning outcome:

- To know how interatomic forces acting on crystal lattice, thermal properties of the solid state matter.
- Optical properties of the matter are understood with the help of electron, phonon, photon interaction.

UNIT II

Crystal growth techniques: Bridgeman-Czochralski-liquid encapsulated czochralski (LEC) growth technique-zone refining and floating zone growth-chemical vapour deposition (CVD)-Molecular beam epitaxy (MOVPE)-vapour phase epitaxy-hydrothermal growth-Growth from melt solutions-Flame fusion method.

Learning outcome:

- To know how to grow crystals using different preparation techniques.
- Understanding the advantages and difficulties in the process of growing crystals.

UNIT III

Absorption in insulators, Polaritons, One – phonon absorption, optical properties of metals, skin effect and anomalous skin effect. Interaction of electrons with acoustic and optical phonons, polarons.

Learning outcome:

- Students can understand the absorption process in insulators then optical properties are observed.
- To know the basic understanding of normal and anomalous skin effect, penetration depth etc.

UNIT IV

Superconductivity: The Meissner effect – Isotope effect- specific heat-thermal conductivity and manifestation of energy gap. Quantum tunneling-Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Vortices and type I and type II superconductors, applications of superconductivity-high temperature superconductivity (elementary).

Learning outcome:

- Understand the basic theory of superconductors and their Type I and II classifications.
- Comprehend the physical concept of BCS theory through formation of cooper pairs.
- Advantages of Josephson effect of superconductors and practical applications of superconductors in various fields.

UNIT V

Characterization Techniques:

X-ray diffraction, data manipulation of diffracted X-rays for structure determination, Scanning Probe microscopy, Scanning Electron microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Optical microscopy, DTA, TGA and DSC measurements.

Learning outcome:

- Understand the basic Instrumentation and working principle of advanced instruments.
- To know the applications of materials using the various techniques.

Course outcome:

- ➢ The students should be able to elucidate the important features of condensed matter physics by covering lattice dynamics, preparation of crystals under different conditions.
- ➢ Students learned the interaction of electrons with phonons, polarons and the absorption phenomenon in insulators and metals.
- ➢ The origin of superconductivity is understood and the classification and different practical applications are explained.
- ➢ Student can understand the various characterization techniques used for materials characterization.

Text and Reference Books

1. Madelung: Introduction to Solid State Theory.
2. Callaway: Quantum theory of Solid State.
3. Huang: Theoretical Solid State Physics
4. Kittel: Quantum theory of Solids
5. Solid state Physics by Guptha Kumar and Sarma
6. Solid State Physics S.O. Pillai New Age International
7. Science of Engineering Materials: C.M. Srivastva and C. Srinivasan-New Age International, 2005.
8. The Principles and Practice of electron Microcopy: Ian. M. Watt-Cambridge University Press, 1997.

Semester 4
M. Sc Physics
PRACTICAL – I
405PH24-ADVANCED ELECTRONICS

- Astable multivibrator using IC741
- Colpitts oscillator
- Demorgons theorem
- D C regulated power supply.
- Summing and averaging amplifier.

Semester 4
M. Sc Physics
PRACTICAL – II
406PH24- ADVANCED CONDENSED MATTER PHYSICS

- Optical absorption
- B H curve
- Thermos EMF
- Hall effect.
- G M Counter

Duration of the Programme:

Minimum: Two Academic Years from the year of joining of the course (Four Semesters). **Maximum:** Five Academic Years from year of joining of the course for securing First Class or Second Class.

INSTRUCTIONAL DESIGN :

Instructional delivery mechanism: University has its own faculty for M.Sc. Physics department and all the faculty members will act as resource persons. Our University has blended mode delivery mechanism i.e., ICT and Conventional modes.

Media of delivery mechanisms:

• **Printing:** The study material delivery media include Printing of books which are issued to the students who are enrolled for the programme.

• **Online:** On line PDF format content is also given access to the students who wish to study through online mode.

• **Interactive sessions, and Discussion boards:** In distance Education, face to face contact between the learners and their tutors is relatively less and therefore interactive sessions are conducted. The purpose of such interactive session is to answer some of the questions and clarify doubts that may not be possible in other means of communication. This programme provides an opportunity to meet other fellow students. The Counsellors at the study centres are expected to provide guidance to the students. The interactive sessions are conducted during week ends and vacations to enable the working students to attend.

• **Student support services:** Student support services include Internet enabled student support services like e-mails, SMS and even an app is planned. Student feed back mechanism is created and feed back is designed. Student Learning Managemnet Sysyem (LMS) is customized to every student. For every student customized examination management system (EMS) is also created facilitationg self evaluation, demo tests, model question papers and periodical Internal Assessments.

• **Credit System**: University has adopted Choice Based Credit System (CBSE) under semester mode from 2013. The same has been approved by relevant Statuatory boards in Distance mode also.

• **Admission procedure:** In M.Sc. (Physics) programme candidates can take admission directly. For this purpose, CDE, ANU will advertise for admissions. Then candidates should apply in prescribed format of the CDE after publication of the advertisement. • Eligibility Criteria: The eligibility for admission into this course is a pass in B.Sc with Physics as one of the subjects of study.

• **Fee Structure:** The total course fee is Rs.29,900/-.

• **Policy of programme delivery:** Our University has blended mode delivery mechanism i.e., ICT and Conventional modes. In conventional mode printed material is given and also online mode of delivery with learning management system is adopted.

• **Activity planner:** There is an yearly academic plan and as per plan interactive sessions, assignments, examinations etc are conducted to the candidates.

• **Evaluation System:** Periodical progress of learning is evaluated by web based feed back mechanism in the Learning Management System. Evaluation of learner progress is conducted as follows:

(i) The examination has two components i.e., continuous evaluation by way os assignments (30 %) and term end University Examination (70 %).

(ii) Each student has to complete and submit assignment in each of the theory paper before appearing to the term end examination. The term end examination shall be of 3 hours duration.

(iii) Minimum qualifying marks in each paper is 40 % indivually in internal and term end examination. The candidates who get 60 % and above will be declared as passin First Division, 50 % to below 60 % as Second Division and 40 % to below 50 % as Third Division.

(iv) THe Centre for Distance Education, Acharya Nagarjuna University will conduct the examinations, evaluations and issue certificates to the successful candidates.

(v) All the term end examinations will be conducted at the examination centres fixed by the CDE.

(vi) Qualitatively the examinations conducted for the students of the Distance Education are on par with the examinations conducted for the regular University students.

LIBRARY SUPPORT AND LIBRARY RESOURCES :

The M.Sc. (Physics) program is based on the theory and practical papers. Laboratory support is available to students. Further, entire University Library is accessble to all the students of distance education. Additionally every department in the University has a well equipped library which is accessable to all the students. CDE also provides a compendium of web resources to every student to support learning.

COST ESTIMATE :

The Programme fee for I year is Rs.14,300/-, and II year is Rs. 15,600/-. The university will pay the remuneration to Editors and lesson writers as per university norms. DTP charges, Printing of books and Examination fees will be paid by the ANUCDE as per prescribed norms. This institution is providing high quality programmes at low cost.

QUALITY ASSURANCE :

Quality assurance comprises the policies, procedures and mechanisms which that specified quality specifications and standards are maintained. These include continuous revision and monitoring activities to evaluate aspects such as suitability, efficiency, applicability and efficacy of all activities with a view to ensure continuous quality improvement and enhancement. The programme is designed with a focus on the proposed learning outcomes aimed at making the learner industry ready also for career advancement, enterprenureal development, and as wealth creators. There is a continuous evaluation of learning and of competence internally and also by ICT enabled feed back mechanism and Centre for Internal Quality Assurance (CIQA). The University ensures maintaining quality in education provided through open and diatance learning mode. As per the need of the information society and professional requirement, the University ensures to change the mechanism from time to time along with enhancement of standard in course curriculum and instructional design. Therefor, the outcomes of the programme can meet the challenges in the changing society.

DIRECTOR
Centre for Distance Education
Acharya Nagarjuna University
Nagarjuna Nagar,
GUNTUR-522 510.

REGISTRAR
ACHARYA NAGARJUNA UNIVERSITY
NAGARJUNA NAGAR-522 510.
GUNTUR (A.P.) INDIA.