Andhra University
Department of Physics
College of Science & Technology
Visakhapatnam 530003, A.P.

M.Sc. Physics
(2 Year Programme)

Course Curriculum
Under Choice Based Credit System (CBCS)

(Effective from 2021-22 Admitted Batches)

AUGUST 2021

ANDHRA UNIVERSITY, VISAKHAPATNAM - 530 003, ANDHRA PRADESH
DEPARTMENT OF PHYSICS

M. Sc. Physics (2 Year Programme)
Choice Based Credit System (CBCS)
2021-22

Preamble

The curriculum for the M. Sc. (Physics) Programme is restructured to cater to the requirement of Choice Based Credit System following the University Grants Commission (UGC) guidelines. In the proposed structure, due consideration is given to Core and Elective Courses along with Ability Enhancement (MOOCS and Value added) Courses. Furthermore, these courses will facilitate systematic and thorough learning towards better understanding of the subject. The systematic and planned curricula divided into two years (comprised of four semesters) shall motivate the student for pursuing higher studies in Physics and inculcate enough skills for becoming a good Physicist. The Programme Highlights are: Distinctive academic curriculum, qualified and competent faculty members, transfer of knowledge through scholarly activities, Interdisciplinary project-based learning, state-of-the-art laboratories, exceptional computational facilities, industry interaction and abroad opportunities.

All the theory and laboratory courses have been designed to have 4 credits each. The ability enhancement courses like MOOCS and Value added papers designed in the third and fourth semesters will have 4 and 2 credits respectively. One of the highlight of our post-graduate program is that quite a good number of elective courses are available for students which are directly linked to the state-of-the-art research being carried out in the Department. Students can choose two such elective courses in Semester III and IV. There is associated laboratory of 4 credits with each of these courses in Semester III. The project work will be allotted in the third semester and will continue in the fourth semester and term-end evaluation for a total of 8 credits of the project will be held at the end of the fourth semester. The major courses that will be covered are: Classical Mechanics, Quantum Mechanics, Mathematical Physics, Numerical Methods, Electronics, Experimental Methods and Data Analysis, Electrodynamics, Statistical Mechanics, Atomic and Molecular Physics, Nuclear and Particle Physics, Solid State Physics, Lasers and Fiber Optics, Materials Science, Nano Materials and project-based learning.

Each theory course in a semester will have 4 hrs per week in contact with the student-teacher interaction, while for laboratory courses, the credits are 4. The student should complete 24 credits each in first and second semesters, 30 credits each in third and fourth semester course work. The minimum percentage of marks to be earned by a student in each course is 40% with an aggregate of 50% in each semester to complete a Post Graduate Degree Programme from the Department of Physics, Andhra University. Other rules related to attendance and evaluation is as per the prevailing guidelines of the University.

DEPARTMENT OF PHYSICS

M. Sc. Physics

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2021-22

PROGRAMME OBJECTIVES

The Department of Physics is committed to impart quality education both in experimental as well as theoretical Physics with special emphasis on 'learning by doing' to produce quality manpower for teaching and research.

The objectives of the M.Sc. Physics Programme are:

1. To impart quality education in Physics to students through well designed courses of fundamental interest and of technological importance.

2. To foster scientific attitude, provide in-depth knowledge of scientific and technological concepts of Physics.

3. To enable the students to acquire deep knowledge in fundamental aspects of all branches of Physics.

4. To enrich knowledge through problem solving, practical training, project work, seminars, tutorials, participation in scientific events, study visits, etc.

5. To familiarize with recent scientific and technological developments.

6. To assist the students in acquiring basic knowledge in the courses like Mathematical Physics, Numerical Methods, Classical Mechanics, Quantum Mechanics, Electromagnetic Theory, Electronics, Experimental Methods, Atomic and Molecular Physics, Nuclear Physics, Solid State Physics and in the specialized thrust areas such as Materials Science, Nano Science, Fiber Optics, Communication Electronics and project-based learning.

7. To create foundation for research and development in Physics and to train students in skills related to research, education and industry.

8. To develop abilities and skills that encourage research and development activities and are useful in day-to-day life.

9. To help students to learn various experimental and computational tools thereby developing analytical abilities to address real time problems.

10. To inculcate scientific bent of mind and attitude relevant to science such as concern for efficiency, accuracy and precision, objectivity, integrity, enquiry, effective communication, ethical responsibilities, initiative and inventiveness.

11. To help students to build-up a progressive and successful career in Physics.

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DEPARTMENT OF PHYSICS

M. Sc. Physics

(2 Year Programme)
Under Choice Based Credit System (CBCS)
2021-22

PROGRAMME OUTCOMES

Upon completion of the M.Sc. Physics Programme Students should:

1. Have acquired substantial knowledge of different areas in Physics, basic knowledge in Mathematics with advanced knowledge in some specialized areas of Physics. Apply this knowledge of principles and concepts of Physics to practical problems. Be able to apply experimental and/or theoretical methods, including the use of numerical methods.

2. Use mathematical techniques and interpret mathematical models of physical behavior. Demonstrate the ability to plan, undertake, and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results.

3. Assess the errors involved in an experimental work and summarize the results in an effective manner. Have some research experience within a specific area of Physics, through a supervised project (Master's dissertation). Be familiar with contemporary research within various fields of Physics and have the background and experience required to model, analyze, and solve advanced problems in Physics.

4. Develop communication skills, both written and oral, for specialized and non-specialized audiences. Be able to recognize the need for continuous learning and develop throughout for the professional career.

5. Facilitate a career in various institutions such as Universities, Colleges, Schools, Research and Development Centers of Public / Private Organizations, etc. Have a sense of academic and social ethics.

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DEPARTMENT OF PHYSICS

M. Sc. Physics

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2021-22

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Upon completion of M.Sc. Physics Programme, the Post Graduates will be able to:

PSO-1

Understand the fundamental and advanced level concepts in classical mechanics, quantum mechanics, electrodynamics, electronics etc.

PSO-2

Learn to carry out experiments in certain advanced areas of Physics such as Modern Physics, Solid state Physics, Microprocessors and Communication Electronics.

PSO-3

A research-oriented learning that develops analytical and integrative problem-solving approaches.

PSO-4

Get an awareness to be persons of integrity, to be responsible citizens with a commitment to deliver good to the society.

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Course Structure & Curriculum

M.Sc. Physics

2021-22

M.Sc. Physics – I Semester – FIRST YEAR

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-101	Classical Mechanics	4	-	80	20	100	40	4
P-102	Introductory Quantum Mechanics	4	-	80	20	100	40	4
P-103	Mathematical Methods of Physics	4	-	80	20	100	40	4
P-104	Electronic Devices & Circuits	4	-	80	20	100	40	4
P-105	Modern Physics Lab 1 (Practical-80 & Record-20)	-	3	100		100	50	4
P-106	Electronics Lab 1 (Practical-80 & Record-20)	-	3	100		100	50	4
	Total					600		24

(T- Theory Hrs /Week, P- Practical Hrs/Week)

M.Sc. Physics – II Semester – FIRST YEAR

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-201	Electrodynamics	4	-	80	20	100	40	4
P-202	Statistical Mechanics	4	-	80	20	100	40	4
P-203	Atomic & Molecular Physics	4	-	80	20	100	40	4
P-204	Nuclear and Particle Physics	4	-	80	20	100	40	4
P-205	Modern Physics Lab 2 (Practical-80 & Record-20)	-	3	100		100	50	4
P-206	Electronics Lab 2 (Practical-80 & Record-20)	-	3	100		100	50	4
	Total					600		24

(T- Theory Hrs /Week, P- Practical Hrs/Week)

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M.Sc. Physics – III Semester – SECOND YEAR

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-301	Solid State Physics	4	-	80	20	100	40	4
P-302	Lasers & Fiber Optics	4	-	80	20	100	40	4
P-303	Elective - I	4	-	80	20	100	40	4
P-304	Elective – II	4	-	80	20	100	40	4
P-305	Digital Electronics & Microprocessor Lab (Practical-80 & Record-20)	-	3	100		100	50	4
P-306	Solid State Physics Lab (Practical-80 & Record-20)	-	3	100		100	50	4
P - 307	**MOOCS Paper**	**ON LINE MODE**						**4**
P - 308	**VALUE Added Paper (IPR Chair Paper)**	**Total 30 hours learning, No Examination**						**2**
	TOTAL					**600**		**30**

(T- Theory Hrs /Week, P- Practical Hrs/Week)

M.Sc. Physics IV Semester – SECOND YEAR

Theory Code	Title of the Paper	T	P	Semester End Exam Marks	Mid Exam Marks	Total Marks	Pass Minimum	Credits
P-401	Advanced Quantum Mechanics	4	-	80	20	100	40	4
P-402	Properties & Characterization of Materials	4	-	80	20	100	40	4
P-403	Elective – I	4	-	80	20	100	40	4
P-404	Elective – II	4	-	80	20	100	40	4
P-405	Project Work Dissertation	-	-			100	50	4
P-406	Project Work Viva	-	-			100	50	4
P - 407	**MOOCS Paper**	**ON LINE MODE**						**4**
P – 408	**VALUE Added Paper (Research Methodology / Skill Development Module)**	**Total 30 hours learning, No Examination**						**2**
	TOTAL					**600**		**30**

(T- Theory Hrs /Week, P- Practical Hrs/Week)

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Electives in ODD 3 Semester

- **Elective-I for Course 303 (4 Credits)***

1. Digital Electronics & Microprocessors
2. Principles of Ultrasonics

- **Elective-II for Course 304 (4 Credits)***

1. Materials Science
2. Radar Systems and Satellite Communications

Electives in Even 4 Semester

- **Elective-I for Course 403 (4 Credits)***

1. Nano Materials
2. Antennas

- **Elective-II for Course 404 (4 Credits)***

1. Communication Electronics
2. Ionospheric Radio Wave Propagation & Sounding Techniques

*** Note: These Electives are offered for the students *only with a minimum intake of 25***

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M.Sc. PHYSICS

SYLLABUS & MODEL QUESTION PAPERS

1st SEMESTER

(Effective from 2021-22 Admitted Batches)

Syllabus

M.Sc. Physics

I SEMESTER

P 101: CLASSICAL MECHANICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

To demonstrate knowledge and understanding of the following fundamental concepts in dynamics of particles and to represent the equations of motion for complicated mechanical systems using the Newtonian, D'Alembert, Lagrangian and Hamiltonian formulation of classical mechanics. The course discusses the planetary motion and kepler's laws, Legendre transformations, canonical transformations, Hamilton's equation of motion, Hamilton-Jacobi equations and its applications .It explains the motion of rigid bodies and Euler's angles, coriolis effect. The course discusses the special theory of relativity and its applications and also gave the introduction to the general theory of relativity.

Learning Outcomes:

Students will be able to know the concepts of classical mechanics describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism. They are able to know about canonical transformations, Hamilton's equations of motion. They are able to understand the concept of planar and spatial motion of a rigid body. They are able to differentiate special theory of relativity and general theory of relativity.

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UNIT-I: Mechanics of a particle. Mechanics of a system of particles, constraints, D'Alembert's principle and Lagrange's equations, Velocity Dependent potentials and the Dissipation function Simple applications of the Lagrangian Formulation
Chapter: 1. Section: 1, 2, 3, 4, 5 & 6.
Hamilton's principle, some techniques of the calculus of variations.Derivation of Lagrange's equations from Hamilton's principle. Conservation theorems and symmetry properties, Energy function and the conservation of Energy
Chapter: 2. Section: 1, 2, 3, 5 & 6

UNIT-II: Reduction to the equivalent one body problem. The equation of motion and first Integrals, The equivalent One – Dimensional problem and classification of orbits, The differential equation for the orbit, and Integrable power –law potentials, Conditions for closed orbits (Bertrand's theorem), The Kepler problem inverse square law of force , The motion in time in the Kepler problem, Scattering in a central force field..
Chapter: 3. Section. 1, 2, 3, 5, 6, 7 & 8
Legendre transformations and Hamilton's equations of motion. Cyclic Coordinates, Derivation of Hamilton's equation of motion from variational principle, Principle of Least Action.
Chapter: 7 Section: 1, 2, 3, 4 & 5.

UNIT-III: Equations of canonical transformation, Examples of Canonical transformations, The harmonic Oscillator, Poisson brackets and other Canonical invariants, Equations of motion, Infinitesimal canonical transformations, and conservation theorems in the poisson bracket formulation, the angular momentum poisson bracket relations.

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Chapter: 8. Section: 1, 2, 4, 5, 6 & 7.
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 in systems of one degree of freedom.
Chapter: 9. Section: 1, 2, 3 & 5.

UNIT-IV:Independent coordinates of rigid body. , The Euler angles, Euler's theorem on the Motion of a rigid body, Infinitesimal rotations, Rate of change of a vector, The Coriolis Effect.
Chapter: 4. Section: 1, 4, 6, 8 & 9.
The Inertia tensor and the moment of inertia, The Eigenvalues of the inertia tensor and the principal axis transformation, Solving rigid body problems and Euler equations of motion, Torque – free motion of a rigid body
Chapter: 5 Section: 3, 4, 5 & 6.
The Eigenvalue equation and the principal axis transformation, Frequencies of free vibration, and normal coordinates, free vibrations of a linear triatomic molecule
Chapter 10 Section: 2, 3 & 4.

UNIT – V: Special Theory of Relativity, Basic Postulates of the Special Theory, Lorentz Transformations, Velocity Addition and Thomas Precession, Relativistic Kinematics of Collisions and Many-Particle Systems, Relativistic Angular Momentum, Lagrangian Formulation of Relativistic Mechanics, Covariant Lagrangian Formulations, Introduction to the General Theory of Relativity.
Chapter 7 Sections 1 to 11.

Text Book:
Classical Mechanics - H. Goldstein

Reference Books:
Classical Mechanics - J. B. Upadhayaya
Classical Mechanics - Gupta Kumar Sharma
Classical Mechanics - N C Rana and P S Joag
Classical Mechanics - Takwale and Puranik
Classical Mechanics - G Aruldhas
Classical Mechanics - C R Mondal
Introduction to Special Relativity - Robert Resnick

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M.Sc. Physics

I SEMESTER

P 102: INTRODUCTORY QUANTUM MECHANICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

It is an experimental fact that often a particle behaves like a wave and a wave behaves like a particle. A wave with a precise wavelength (momentum) does not possess a precise location and vice versa. Such uncertainties in conjugate measurable properties and the consequences there of, constitute the essential content of quantum mechanics. Elementary quantum mechanics is the focus of this course. This course provides an understanding of the formalism and language of non-relativistic quantum mechanics. This course will be helpful in understanding the concepts of time-independent perturbation theory and their applications to physical situations.

Learning Outcomes:

1. The students will be able to formulate and solve problems in quantum mechanics using Dirac representation. 2. The students will be able to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules. 3. The students will be familiar with various approximation methods applied to atomic, nuclear and solid-state physics. 4. This course is organized in such a way that a student at the end, is skilled enough to understand the advance level Quantum Mechanics.

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UNIT-I: Failures of classical physics, Origin of Quantum theory, the Conceptual aspect: Modifications needed to the classical concepts of particles and Waves (Wave Particle Duality), Interpretations of Quantum mechanics, Applications of uncertainty principle, Principle of superposition - Wave packets, Schrodinger Wave Equation, wave function interpretation, Problems and admissibility conditions, probability current density, expectation value, Ehrenfest theorem, stationary states.

UNIT-II: Bracket notation, orthonormal functions, linear operators and their properties, Hermitian operator, Schmidt orthogonalization, Postulates of quantum mechanics, simultaneous measurability of observables, commutator algebra, equation of motion of an operator (Schrodinger representation), Momentum representation - Dirac delta function and properties.

UNIT-III: One dimensional problems - Particle in a potential well with (i) infinite walls, (ii) finite walls. Potential step, Potential Barrier. Linear Harmonic Oscillator (Schrodinger method). Free particle. Particle moving in a spherically symmetric potential, spherical harmonics, radial equation. Eigen values and Eigen functions of rigid rotator, hydrogen atom, Hydrogenic orbitals, angular momentum operators, commutation relations, Eigen values and Eigen functions of L^2, L_z, L_+ and L_- operators, spin angular momentum, general angular momentum.

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UNIT-IV: Time- independent perturbation theory for **(i)** non-degenerate systems and application to ground state of helium atom., effect of electric field on the ground state of hydrogen, spin orbit coupling (ii) degenerate systems, application to linear stark effect in hydrogen. Variation method and its application to helium atom, exchange energy and low lying excited states of helium atom. WKB method, barrier penetration.

UNIT – V: Hidden variables, EPR paradox, Bell's theorem, the problem of measurement, time evaluation of a system, discrete or continuous, Q bits and quantum logic gates. (B. H. Bransden and C. J. Joachain; Richard Liboff).

Text Book:

Quantum Mechanics - E. Merzbacher

Reference Books:

1. Quantum Mechanics - G. Aruldhas
2. Quantum Mechanics - G. S. Chaddha
3. Quantum Mechanics - B. H. Bransden and C. J. Joachain
4. Quantum Mechanics - R. D. Ratna Raju
5. Quantum Mechanics - Richard Liboff
6. Quantum Mechanics - Ghatak and Lokanathan
7. Quantum Mechanics - Gupta Kumar Sharma
8. Quantum Mechanics - Mathews and Venkatesan
9. Quantum Chemistry - Ira N. Levine
10. Quantum Mechanics - Nouredine Zettili

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M.Sc. Physics

I SEMESTER

P 103 : MATHEMATICAL METHODS OF PHYSICS

(Effective from 2021-22 Admitted Batches)

Course Objectives:

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

To expose the students towards the fascinating world of complex analysis.

To make the students learn about special functions essential in solving physics problems.

To make them understand about Fourier series and Fourier transforms.

To expose the students get acquainted with the various numerical methods.

To make them understand about tensor analysis.

Learning Outcomes:

1. The students will be able to understand and apply the mathematical skills to solve quantitative problems in the study of Physics.

2. Will enable students to apply integral transform to solve mathematical problems of interest in Physics.

3. The students will be able to use Fourier transforms as an aid for analyzing experimental data.

4. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

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Unit I: Complex Variables
Function of complex number- definition-properties, analytic function-Cauchy –Riemann conditions-polar form-problems, Complex differentiation, complex integration –Cauchy's integral theorem- Cauchy's integral formulae-multiply connected region- problems, Infinite series-Taylor's theorem- Laurrent's theorem-Problems, Cauchy's Residue theorem- evaluation of definite integrals-problems.

Unit II: Beta, Gamma Functions &Special Functions
Beta & Gamma functions -definition, relation between them- properties-evaluation of some integrals Special Functions- Legendre Polynomial, Hermite Polynomial, Laguerre Polynomial, Bessel Function - Generating function-recurrence relations - Rodrigue's formula-orthonormal property-associated Legendre polynomial- simple recurrence relation-orthonormal property-spherical harmonics.

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Unit III: Laplace Transforms & Fourier series, Fourier Transforms
Laplace Transforms – definition- properties – Laplace transform of elementary functions-Inverse Laplace transforms-properties- evaluation of Inverse Laplace Transforms-elementary function method-Partial fraction method-Heavyside expansion method-Convolution method-complex inversion formula method-application to differential equations.
Fourier series-evaluation of Fourier coefficients- Fourier integral theorem-problems-square wave-rectangular wave-triangular wave, Fourier Transforms- infinite Fourier Transforms-Finite Fourier Transforms-Properties-problems-application to Boundary value problem.

Unit IV: Numerical Methods
Linear and non- linear curve fitting, least square fitting, Chi – square test, Errors of Coefficients.
Solutions of algebraic and transcendental equations-Bisection method-method of successive approximations-method of false position Iteration method-Newton Rapson method Simultaneous linear algebraic equations-Gauss elimination method-Gauss Jordan method-Matrix inversion method-jacobi method – Gauss-Siedel method.
Interpolation with equal intervals-Finite differences-Newton Forward & Backward Interpolation formulae, Interpolation with unequal internals-Newton's divided difference formula-Lagrange interpolation formula Numerical Integration-General Quadrature formula-Trapezoidal rule -Simpson's 1/3 rule & 3/8 rule.
Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Unit V: Tensor Analysis
Introduction, Transformation of Co-ordinates, Contravariant, Covariant and Mixed tensors, Addition, Subtraction, Contraction, Multiplication, Quotient Law, Symmetric and Anti Symmetric tensors, The line element, Fundamental Tensors, Covariant differentiation, Christoffel Symbols, Curvature tensor, Riemann curvature, Application of Tensors.

Text Books:
1. Mathematical Methods of Physics - G. Arfken
2. Mathematical Physics - Satya Prakash
3. Complex Variables - Murray R Spiegel - Schaum's outline series
4. Mathematical Physics - B.S. Rajput
5. Laplace n Fourier Transforms - Goyal & Gupta
6. Introductory methods of Numerical analysis - S. S. Sastry
7. Fundamentals of Mathematical Statistics – S C Gupta & V K Kapoor
8. Tensor Calculus – A Concise Course – Barry Spain

Reference Books:
1. Numerical Methods - V. N. Vedamurthy & N. Ch. S. N. Iyengar
2. Mathematical Methods - B. D. Gupta
3. Special Functions - Gupta & Sharma
4. Integral Transforms - M. D. Raisinghanna
5. Integral Transforms - Goyal & Gupta
6. Fundamentals of Statistics - S C Gupta
7. Probability and Statistics - Murray R Spiegel - Schaum's outline series
8. Tensor Calculus - David C Kay – Schaum 's outline series

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M.Sc. Physics

I SEMESTER

P 104: ELECTRONIC DEVICES AND CIRCUITS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

To make the students familiar about the concepts of components used in various electronic devices.

To make the students learn and understand the basics of analogue electronics.

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

Learning Outcomes:

The students will be able to use techniques for analyzing analogue electronic circuits; and formulate the concepts of semiconductor devices, microwave devices, operational amplifier circuits and electronic measurements, instrumentation and experimental methods.

At the end of this course, the students will be able to understand the fundamentals behind analog devices.

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UNIT-I

Semiconductor Devices:
Tunnel diode, Photo Diode, Solar Cell, LED, Silicon Controlled Rectifier (SCR), Uni Junction Transistor (UJT), Field Effect Transistor (JFET & MOSFET), CMOS.

UNIT-II

Microwave Devices:
Varactor Diode, Parametric Amplifier, Thyristors, Klystron, Reflex Klystron, Gunn Diode, Magnetron, CFA, TWT, BWO, IMPATT, TRAPATT, APD, PIN Diode, Schottky Barrier Diode.

UNIT-III

Operational Amplifier (OP AMP):
The ideal Op Amp – Practical inverting and Non inverting Op Amp stages, Op Amp Architecture – differential stage, gain stage, DC level shifting, output stage, offset voltages and currents. Virtual ground.
Operational Amplifier parameters- input offset voltage, input bias current, Band width, Common Mode Rejection Ratio (CMRR), Slew Rate.
Op Amp open loop gain configuration, Differential amplifier, Inverting and Non-inverting amplifiers.
Op-amp with negative feedback- effect of feedback on closed loop gain input resistance, output resistance, bandwidth and output offset voltage - voltage follower.

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UNIT-IV

OP AMP Applications:

Summing amplifier, Integrator, Differentiator
Voltage to Current converter, Current to Voltage converter
Logarithmic Amplifier, Instrumentation Amplifier
Oscillators – Phase shift oscillator, Wien-Bridge Oscillator
Special applications – Monostable and Astable multivibrators using 555, Schmitt Trigger, Voltage Controlled Oscillator (VCO), Phase Locked Loop (PLL), IC 723 Voltage regulator.

UNIT – V

Electronic Measurements, Instrumentation and Experimental Methods:

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors
Transducers (temperature, pressure, vibration, optical, and particle detectors)
Measurement and control. Signal conditioning and recovery, Impedance matching, Amplification, Filtering and noise reduction, Shielding and grounding.

Text Books:

1. Integrated Electronics - Jacob Millman & C.C. Halkies
2. Op.Amps and Linear Integrated Circuits - Ramakant A.Gayakwad
3. Electronic Communication Systems - George Kennedy
4. Electronic Instrumentation and measurement techniques – W D Cooper & A D Helfric
5. A course in electrical and electronic measurements and instrumentation – A K Sawhney
6. Electronic Instrumentation – H S Kalsi

Reference Books:

1. Microelectronics - Jacob Millman & Arvin Grabel
2. Electronic Devices and Circuits - G.K. Mithal
3. Electronic devices and circuit theory - Robert Boylested & Louis Nashlsky
4. Electronic Principles - AP Malvino & J Bates
5. Micro Electronics - Sedra and Smith
6. Linear Integrated Circuits - D Roy Choudhury & Shail Jain
7. Introduction to electronic devices - Micheal Shur
7. Semi Conductor Electronics - A.K.Sharma
8. Anlog and Digital Electronics – Nagarath
6. Op-amps and Linear Integrated Circuits - D. Mahesh Kumar
9. Electronic instrumentation and measurements – David A Bell
10. Modern Electronic Instrumentation and measurement techniques –A D Helfric & W D Cooper
11. Electronic Measurements and Instrumentation - Oliver and Cage

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Syllabus

M.Sc. Physics

I SEMESTER

P 105: MODERN PHYSICS LAB 1

(Effective from 2021-22 Admitted Batches)

LIST OF EXPERIMENTS

Course Objectives:

The aim of this laboratory course is to make the students perceive some of the fundamental laws of Physics through experiments.

Learning Outcomes:

At the end of this laboratory course, the students will be capable of handling sophisticated instruments besides learning the Physics concepts behind these experiments.

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1. Atomic Spectrum of Sodium
2. Atomic Spectrum of Zinc
3. Rydberg's Constant using Grating
4. Raman Spectrum of Carbon Tetrachloride
5. Specific Charge of an Electron using Thomson's Method
6. Determination of Planck's Constant

Reference Books:

1. Advanced Practical Physics, B.L. Worsnop & H.T. Flint.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna.
3. Practical Physics, Geeta Sanon, R. Chand & Co.Publishers.
4. Advanced Practical Physics, S P Singh, Pragati Prakashan.
5. Practical Physics, Gupta & Kumar, Pragati Prakashan.
6. An Advanced Course in Practical Physics, D Chattopadhyay & P C Rakshit, Central Pub.

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Andhra University
VISAKHAPATNAM-530 003

Syllabus

M.Sc. Physics

I SEMESTER

P 106: ELECTRONICS LAB 1

(Effective from 2021-22 Admitted Batches)

LIST OF EXPERIMENTS

Course Objectives:

To make the students familiar with analog electronic components.

To provide hands-on experience to the students to make them familiar with the working and handling of the analog electronic devices and circuits.

Learning Outcomes:

At the end of this laboratory, the students will be skilled enough to handle and understand the use of analog devices.

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1. FET Amplifier (BFW 10/11)
2. Negative Feedback Amplifier (BC 147)
3. Colpitts Oscillator (BF 194)
4. Phase Shift Oscillator (BC 147)
5. Astable Multivibrator (BF 194)
6. Op. Amp. Characteristics (IC 741)

Reference Books:

1. The Art of Electronics, P. Horowitz & W. Hill.
2. Microelectronics, J. Millman & A. Grabel.
3. Electronic Devices and Circuits, Schaum's Outline Series, J.J. Cathey.
4. Basic Electronics: A Text-Lab Manual, Paul Zbar & Albert P Malvino.
5. Experiments in Electronics, S V Subrahmanyam.
6. Operational Amplifiers & Linear ICs, S V Subrahmanyam.

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M.Sc. Physics Programme

Matrix Mapping of PO's vs CO's

(FIRST SEMSTER)

P 101: CLASSICAL MECHANICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3					
PO-4			✓		
PO-5					

P 102: INTRODUCTORY QUANTUM MECHANICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3					
PO-4					
PO-5			✓		

P 103: MATHEMATICAL METHODS OF PHYSICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓	✓			
PO-2					
PO-3			✓		
PO-4				✓	
PO-5					

P 104: ELECTRONIC DEVICES AND CIRCUITS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3	✓				
PO-4		✓			
PO-5					

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P 105: MODERN PHYSICS LAB - 1

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3	✓				
PO-4					
PO-5	✓				

P 106: ELECTRONICS LAB - 1

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3	✓				
PO-4					
PO-5	✓				

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M.Sc. PHYSICS

SYLLABUS & MODEL QUESTION PAPERS

2nd SEMESTER

(Effective from 2021-22 Admitted Batches)

Syllabus

M.Sc. Physics

II SEMESTER

P 201: ELECTRODYNAMICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. To evaluate fields and forces and potentials in Electrodynamics and Magneto dynamics using basic scientific method.
2. To make the students understand the propagation behavior of electromagnetic waves in different media.
3. To be capable of understanding the physical interpretation of Maxwell's Equations.
4. To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.

Learning Outcomes:

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

***

UNIT-I: Gauss's law and its applications, Poisson equation, Laplace equations, Uniqueness theorem, boundary value problems, separation of variables, solution to Laplace's equation in Cartesian, spherical, and cylindrical coordinates, use of Laplace's equation in the solutions of electrostaticproblems.

UNIT-II: Biot-Savart law, Ampere's theorem, Faraday's law of electromagnetic induction, magnetic vector potential, displacement current, Maxwell's equations, differential and integral forms, physical significance of Maxwell's equations, Maxwell's equations in free space, Maxwell's equations inside matter, boundary conditions on the fields at interfaces.

UNIT-III: Wave equation, plane electromagnetic waves in free space , in non-conducting isotropic medium, in conducting medium, electromagnetic vector and scalar potentials, uniqueness of electromagnetic potentials and concept of gauge, Lorentz gauge, Coulomb gauge, motion of charged particles in uniform electric field, charged particles in homogenous and non-homogeneous magnetic fields, charged particles in simultaneous electric and magnetic fields.

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UNIT-IV: Lienard-Wiechert potentials from a moving charge, electromagnetic fields from Lienard-Wiechert potentials of a moving charge, electromagnetic fields of a uniformly moving charge, radiation from moving charges and dipoles, radiation from an accelerating charge, Bremsstrahlung radiation, Cherenkov radiation and application.

UNIT-V: Lorentz transformations, transformation of electromagnetic potentials, E and B fields from Lorentz transformations, covariance and contra variance, Electromagnetic field tensor and Lorentz invariance of Maxwell's equations.

Text books:

1. Classical Electrodynamics - J. D. Jackson
2. Introduction to Electrodynamics - D.R. Griffiths

Reference Books:

1. Electromagnetic Theory and Electrodynamics - Satyaprakash
2. Electrodynamics - K.L Kakani

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M.Sc. Physics

II-SEMESTER

P202: STATISTICAL MECHANICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

The course gives an introduction to statistical mechanics and includes the concepts of phase space, ensembles and calculations of thermodynamic parameters using the concepts of ensembles. The course also discusses partition functions and their properties and its applications. It explains quantum statistics such as Maxwell-Boltzmann statistics, Bose-Einstein and Fermi-Dirac statistics, Bose-Einstein condensation,theory of dwarf stars. The course also describes phase transitions and calculation of partition function for non-ideal classical gas.

Learning Outcomes:

On completion of course, the student should be able to understand the concepts of phase space, different kinds of ensembles and how to obtain the thermodynamic parameters using this concepts. They are also able to know what Gibb's paradox is and how to resolve it. They are able to differentiate types of quantum statistics and able to know the difference between ideal and non-ideal classical gas. They are able to understand types of orders of phase transitions.

UNIT-I: Basic Methods and Results of Statistical Mechanics:

Phase space, Isolated systems, Basic postulates, concept of ensembles, different types of ensembles – probability calculations according to micro canonical, canonical and grand canonical ensemble (system with an indefinite number of particles & system in macroscopic motion), simple applications of canonical distribution, system with specified mean energy, calculation of mean values in a canonical ensemble, connection with thermodynamics, Liouvilles theorem,Energy fluctuations in the canonical ensemble. Density and energy fluctuations in the grand canonical ensemble.Thermodynamic equivalence of ensembles.

Reif Chapter: 6.

UNIT-II: Simple Applications of Statistical Mechanics:

Partition functions and their properties.Calculation of thermo dynamic quantities to an ideal mono atomic gas.Gibbs paradox, validity of the classical approximation.Proof of the equipartition theorem. Simple applications – mean K.E. of a molecule in a gas. Brownian motion.Harmonic Oscillator, Partition function for polyatomic molecules, Electronic energy, vibrational energy and rotational energy of a diatomic molecule.Effect of Nuclear spin-ortho and para Hydrogen.

Reif Chapter: 7 & 9.12

UNIT-III: Quantum Statistics:

Formulation of the statistical problem.Maxwell–Boltzmann statistics. Photon statistics, Bose-Einstein statistics, Fermi–Dirac statistics, Quantum statistics in the classical limit, calculation of dispersion for MB, BE & FD statistics Equation of state of an Ideal Bose Gas,Bose-Einstein condensation.

Reif Chapter: 9

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UNIT-IV: Non Ideal Classical Gas:

Calculation of the partition function for low densities. Equation of state and virialcoefficients,Alternative derivation of Van Der Walls equation.Black body radiation,Thermionic emission. The theory of white dwarf stars

Reif Chapter: 10.3, 10.4

UNIT – V: Phase Transitions

Phase transitions, conditions for Phase equilibrium, First order Phase transition – the Clausius–Clayperon equation, Second order phase transition, the critical indices, Van der Waals theory of liquid gas transition. Order parameter, Landau theory.

Sinha Chapter: 10

Text Books

1. Fundamentals of Statistical and Thermal Physics - F. Reif

Reference Books:

1. Statistical Mechanics, Theory and Applications - S. K. Sinha
2. Statistical Mechanics - R. K. Pathria
3. Statistical Mechanics - KersonHuang
4. Statistical Mechanics - Gupta Ram

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Syllabus

M.Sc. Physics

II SEMESTER

P 203: ATOMIC AND MOLECULAR PHYSICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. To provide an understanding of the fundamental aspects of atomic and molecular physics.
2. To make the students understand various couplings effects.
3. To study spectroscopy of the one electron, one valence electron, multi-electron atoms and diatomic molecules.
4. To make the students understand about various absorption/emission spectroscopic transitions.
5. To make the students understand Quantum mechanical phenomenon at the atomic and molecular level.
6. To make the students understand the molecular orbits using Electronic Spectroscopy and Resonance Raman Spectra.

Learning Outcomes:

The students will be able to understand the normal and anomalous splitting of atomic and molecular energy levels.

The students will have an understanding of quantum behavior of atoms in external electric and magnetic fields.

The students will be capable to understand infrared spectroscopy.

The students will understand the spectroscopy of molecules using Raman Effect.

The students will be able to understand the molecular vibrations using the Group Theory.

***

UNIT-I

One Electron Atoms:

Derivation of Quantum numbers, Term values, Relation between Magnetic dipole moment and angular momentum of an orbiting electron, Spin- orbit interaction, relativistic kinetic energy correction and dependence of energy on J value only, Selection rules. Fine structure of Hydrogen spectra, Fowler series of ionized Helium, Hyperfine structure of Hα line of hydrogen (I = ½).

One Valence Electron Atoms:

Modified term values (quantum defect) due to lifting of orbital degeneracy by core penetration (penetrating orbits), core polarization (non-penetrating orbits) by nl electrons. Term values, Fine structure of chief spectral series of sodium, Intensity rules and application to doublets of sodium. Hyperfine structure of ^2P-^2S transition of sodium (I= 3/2).

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UNIT-II

Many Electron Atoms:

Indistinguishable particles, bosons, fermions, Pauli's principle, Ground states, LS coupling and Hund's rules based on Residual columbic interaction and spin-orbit interaction, Lande's interval rule, Equivalent and non-equivalent electrons, Spectral terms in LS and JJ coupling (ss,s2 ,pp,p2 configurations), Exchange force and Spectral series of Helium.

UNIT - III

Atoms in External Magnetic Field : Normal Zeeman effect, Anomalous Zeeman effect and Paschen-Back effects and application to ^2P-^2S, ^3P-^3S, transitions.

Atoms in External Electric Field: Linear stark pattern of Hα line of hydrogen, Quadratic stark pattern of D1 and D2 lines of Sodium.

UNIT-IV

Diatomic Molecules:

Molecular quantum numbers, Bonding and anti-bonding orbitals from LCAO's, Explanation of bond order for N2 and O2 and their ions, Rotational spectra and the effect of isotopic substitution, Effect of nuclear spin functions on Raman rotation spectra of H2 (Fermion) and D2 (Boson), Vibrating rotator and its spectrum, Combination relations and evaluation of rotational constants (infrared and Raman), Intensity of vibrational bands of an electronic band system in absorption.(The Franck-Condon principle), Sequences and progressions, Deslandre's table and vibrational constants.

UNIT- V

Molecular Vibrations:

Symmetry elements, operations and identification of point Groups of AH_2, A_2H_2, ABH_2, AB_2H_2, AH_3, and ABH3 type molecules, Properties of irreducible representations and C2v character table. Reducible representation and symmetry in fundamental vibrations of H_2O. Structure determination of AB_2 type molecules from observed and expected fundamental bands of Raman and IR Spectra.

Molecular orbitals:

Walsh diagram, Electronic spectroscopy, Herzberg – Teller effect, Resonance Raman Scattering, Fluorescence and Resonance Raman Spectra, Non linear effects and Raman Spectra.

Text Books:

1. Introduction to Atomic Spectra - H. E. White
2. Atomic and Molecular Spectra - Rajkumar
3. Fundamentals of Molecular Spectroscopy - C. N. Banwell
4. Group Theory - K. V. Raman

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Syllabus

M.Sc. Physics

II SEMESTER

P 204: NUCLEAR AND PARTICLE PHYSICS

(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) To familiarize about the essential properties of the nucleus such as its shape, size, radius, density, magnetic moment, electric quadruple moment etc.
2) In order to probe these properties several models have been proposed such as liquid drop model, shell models, collective models.
3) The most useful part of this knowledge is the nuclear energy which has immense applications.
4) The concept behind this energy was first given by Hans Bethe in the form of semi-empirical mass formula which is in the course content.
5) Carbon dating, modern medical applications, radio-physics all require the knowledge of radio-activity.
6) It is a well-known fact that all kind of interactions which we perceive in our life are essentially four in number viz. gravitational, electromagnetic, weak and strong.
7) The ultimate aim of particle physics is to unify these interactions.

Learning Outcomes:

1) Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.
2) Discuss nuclear and radiation physics connection with other physics disciplines – solid state, elementary particle physics, radiochemistry.
3) Discuss nuclear and radiation physics applications in medical diagnostics and therapy, energetic, geology, archaeology.
4) Describe experimental techniques used (or developed) for nuclear physics purposes (gamma cameras, semiconductor detectors) and discuss their influence on development of new technologies.
5) Explore an application of nuclear and/or radiation physics and communicate their understanding to a group of their peers in a short presentation.
6) The students will be able to do higher studies in this field.
7) The students may get employment opportunities in radiology and medical field.

***

UNIT – I

Introduction:

Objective of Studying Nuclear Physics, Nomenclature, nuclear radius, mass & Binding energy, angular momentum, magnetic dipole moment, Electric quadrupole moment, parity and symmetry, domains of instability, mirror nuclei.

Nuclear Forces: Simple theory of the deuteron, scattering cross-sections, qualitative discussion of neutron-proton and proton- proton scattering, exchange forces, Yukawa's Potential, Characteristics of Nuclear Forces.

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UNIT – II

Nuclear Models: Liquid drop model: Weissacker's semi-emperical mass formula, Mass – parabolas. Nuclear shell model : Spin orbit interaction, magic numbers, prediction of angular momenta and parities for ground states, Collective model. More-relistic models.

Nuclear Decay: Aplha decay process, Energy release in Beta-decay, Fermi's Theory of β - decay, parity violation in β -decay, detection and properties of neutrino. Energetics of gamma decay, selection rules, angular correlation, Mossbauer Effect.

UNIT – III

Nuclear Reactions: Types of reactions and conservation laws, the Q – equation, Optical model.

Nuclear Energy: Stability limit against spontaneous fission, Characteristics of fission, delayed neutrons, four factor formula for controlled fission, nuclear fusion, prospects of continued fusion energy.

UNIT – IV

Nuclear Radiation Detectors: Interaction of radiation with matter. Gas filled counters, scintillation detectors, semiconductor detectors, energy measurements, coincidence measurements and time resolution, magnetic spectrometers.

Accelerators: Electrostatic accelerators, cyclotron accelerators, synchrotrons, linear accelerators, colliding beam accelerators.

Applications: Trace Element Analysis, Rutherford Back-scattering, Diagnostic Nuclear Medicine, Therapeutic Nuclear Medicine.

UNIT – V

Elementary Particles: Particle interactions and families, conservation laws (energy and momentum, angular momentum, parity, Baryon number, Lepton number, isospin, strangeness quantum number (Gellmann and Nishijima formula) and charm, Elementary ideas of CP aand CPT invariance, Quark model.

Text Books:

1. Introductory Nuclear Physics - Kenneth S. Krane
2. Elementary Particle Physics – M J Longo

Reference Books:

1. Introduction to Nuclear Physics - Harald A.Enge
2. Concepts of Nuclear Physics - Bernard L.Cohen.
3. Introduction to High Energy physics - D.H. Perkins
4. Introduction to Elementary Particles - D. Griffiths

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M.Sc. Physics

II SEMESTER

P 205: MODERN PHYSICS LAB 2

(Effective from 2021-22 Admitted Batches)

LIST OF EXPERIMENTS

Course Objectives:

The aim of this laboratory course is to make the students perceive some of the fundamental laws of Physics through experiments.

Learning Outcomes:

At the end of this laboratory course, the students will be capable of handling sophisticated instruments besides learning the Physics concepts behind these experiments.

***

1. He-Ne Laser
2. Band Gap of a Semiconductor (Two probe Method)
3. Determination of Curie Temperature
4. Characteristics of LED and Laser Diode
5. Reciprocal Dispersion Curve
6. Vibrational Analysis of ALO Band Spectrum

Reference Books:

1. Advanced Practical Physics, B.L. Worsnop & H.T. Flint.
2. A Text Book of Practical Physics, I.Prakash & Ramakrishna.
3. Practical Physics, Geeta Sanon, R. Chand & Co.Publishers.
4. Advanced Practical Physics, S P Singh, Pragati Prakashan.
5. Practical Physics, Gupta & Kumar, Pragati Prakashan.
6. An Advanced Course in Practical Physics, D Chattopadhyay & P C Rakshit, Central Pub.

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Syllabus

M.Sc. Physics

II SEMESTER

P 206: ELECTRONICS LAB 2

(Effective from 2021-22 Admitted Batches)

LIST OF EXPERIMENTS

Course Objectives:

To make the students familiar with analog electronic components.

To provide hands-on experience to the students to make them familiar with the working and handling of the analog electronic devices and circuits.

Learning Outcomes:

At the end of this laboratory, the students will be skilled enough to handle and understand the use of analog devices.

***

1. Active low, High and Band Pass Filters (IC 741)
2. Twin – T Filter (IC 741)
3. Logarithmic Amplifier (IC 741)
4. Wein Bridge Oscillator (IC 741)
5. Monostable Multivibrator (IC 555)
6. Voltage Regulator (IC 723)

Reference Books:

1. The Art of Electronics, P. Horowitz & W. Hill.
2. Microelectronics, J. Millman & A. Grabel.
3. Electronic Devices and Circuits, Schaum's Outline Series, J.J. Cathey.
4. Basic *Electronics*: *A Text-Lab Manual*, Paul Zbar & Albert P Malvino.
5. Experiments in Electronics, S V Subrahmanyam.
6. Operational Amplifiers & Linear ICs, S V Subrahmanyam.

M.Sc. Physics Programme

Matrix Mapping of PO's vs CO's

(SECOND SEMSTER)

P 201: ELECTRODYNAMICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3		✓			
PO-4			✓		
PO-5				✓	

P 202: STATISTICAL MECHANICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2			✓		
PO-3		✓			
PO-4				✓	
PO-5					

P 203: ATOMIC AND MOLECULAR PHYSICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1					
PO-2			✓		
PO-3	✓	✓			
PO-4				✓	
PO-5					

P 204: NUCLEAR AND PARTICLE PHYSICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1		✓	✓		
PO-2				✓	
PO-3	✓				
PO-4					
PO-5					

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P 205: MODERN PHYSICS LAB - 2

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3	✓				
PO-4					
PO-5	✓				

P 206: ELECTRONICS LAB - 2

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3	✓				
PO-4					
PO-5	✓				

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M.Sc. PHYSICS

SYLLABUS & MODEL QUESTION PAPERS

3rd SEMESTER

(Effective from 2021-22 Admitted Batches)

Syllabus

M.Sc. Physics

III SEMESTER

P 301: SOLID STATE PHYSICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) To provide extended knowledge of principles and techniques of Solid State Physics.
2) To make the students familiar with the structures having regular and irregular arrangements of atoms and their bonding etc.
3) To explain the peculiar behavior of materials.
4) To understand various thermal properties of materials under different length scales.
5) To explain the free electron Fermi gas energy levels and density of orbits.
6) To understand the band theory of solids.

Learning Outcomes:

1) The students will be able to formulate basic models for electrons and lattice vibrations for describing the physics of crystalline materials.
2) The students will be able to understand the relation between band structure and the thermal properties of a material.
3) At the end of this course, the students will be able to understand various physical phenomena and the reasons behind them.

***

UNIT-I: Crystal Structure
Periodic array of atoms—Lattice translation vectors, fundamental types of lattices-two and three dimensional lattice types, the Basis and the Crystal Structure, Primitive and compound unit cells, determination of number of atoms in a cell and position of atoms, simple crystal structures--sodium chloride, cesium chloride and diamond structures, Review of Symmetries in solid, Miller Indices, indexing pattern of cubic crystals and non-cubic crystals (analytical methods).

UNIT-II: X-Ray Diffraction and Reciprocal Lattice
Diffraction of x-rays by crystals, scattered wave amplitude-Fourier analysis, Bragg's law, Laue's equations, Reciprocal lattice vectors, diffraction conditions, reciprocal lattice to bcc and fcc Lattices, concept of Brillouin Zone, Ewald construction, Structure factor and atomic form factors.

UNIT-III: Lattice Vibrations
Vibrations of lattice with monoatomic and diatomic basis, dispersion relation, optical and acoustical branches, quantization of elastic waves and phonons, classical theory of specific heat, phonon density of states, Einstein and Debye models of specific heat.

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UNIT-IV: Free Electron Fermi Gas

Free electron theory and electronic specific heat, energy levels and density of orbits in one dimension, free electron gas in three dimension, thermal properties of an electron gas, Hall effect, thermal conductivity, Wiedemann-Franz law.

UNIT-V: Band Theory of Solids

Nearly free electron model and origin of energy gap, Block function, Kronig-Penny Model, wave equation of electron in a periodic potential, Bloch theorem and crystal momentum, classification of metals, insulators and semiconductors.

Text Books:

1. Introduction to Solid State Physics - C. Kittel
2. Solid State Physics - A. J .Dekker

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Syllabus

M.Sc. Physics

III SEMESTER

P 302: LASERS AND FIBER OPTICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) To explain the basics of LASER.
2) Describing the construction and working of various types of lasers and the applications of lasers.
3) Explaining the propagation mechanism of light through optical fiber.
4) Deriving the relation between Numerical Aperture and Refractive indices.
5) Classification of the types of optical fibers.
6) Explaining about the attenuation mechanisms.
7) Demonstrate an understanding of light propagating through an optical fiber
8) Characterize different types of optical fibers and optical connectors

Learning Outcomes:

1. Absorption and spontaneous and stimulated emission in two level system, the effects of homogeneous and inhomogeneous line broadening, and the conditions for laser amplification.
2. Operations of the cavity including mode separation and line-widths, laser gain conditions, gain clamping in both homogeneous and inhomogeneous line broadened media.
3. Operations and basic properties of the most common laser types such as Ruby, He-Ne, Nd:YAG and knowledge of other main laser types.
4. The various laser systems, the simple homogeneous laser and its output behavior and optimal operating conditions.
5. Spectral properties of longitudinal and transverse modes, mode locked laser operation, schemes for active and passive mode locking in real laser system.
6. Matrix optics of the laser cavity and stability conditions.
7. Basics of Gaussian beam in laser cavity and optical properties of laser output, design of stable laser cavities using Gaussian beam optics, the ABCD law for Gaussian beams.
8. Better understanding of the Ray and Modal Analysis in Optical Fibers.
9. Basic understanding about the various Fiber Signal Characteristics such as pulse broadening and dispersion.
10. Exhaustive understanding about the Non linear optics.

***

UNIT-I

Laser systems: Introduction, Characteristics of Laser Light, coherence, directionality, spontaneous and stimulated emission, absorption and emission processes, Einstein coefficients, Optical pumping mechanism, Population inversion, Rate equations for three level and four level systems, Types of Lasers - Ruby laser, He-Ne laser, Nd:YAG laser, CO_2 Laser, Dye laser, Excimer laser, Semiconductor laser, Hetero junction laser, Optical resonator, laser power and threshold condition confinement of beam within the resonator, coherence length, stability condition, stability diagram.

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UNIT – II:

Laser cavity modes: Line shape function and Full Width at half maximum (FWHM) for Natural broadening, Collision broadening, Doppler broadening. Saturation behavior of broadened transitions, Longitudinal and Transverse modes. ABCD matrices and cavity Stability criteria for confocal resonators. Quality factor, Q-Switching, Mode Locking in lasers. Expression for Intensity for modes oscillating at random and modes locked in phase. Methods of Q-Switching and Mode locking.

UNIT-III

Optical fiber waveguides: Basic optical laws and self-focusing. Optical fiber modes and configurations Fiber types, Rays and Modes, Step-index fiber structure. Ray optics representation, wave representation. Mode theory of circular step-index wave guides. Wave equation for step-index fibers, modes in step-index fibers and power flow in step-index fibers. Graded – index fiber structure, Graded-index numerical aperture, modes in Graded-index fibers.

UNIT-IV

Fiber characteristics: Signal Degradation In Fibers - Attenuation, Absorption, Scattering and Bending losses in fibers, radiative losses, Core and Cladding losses. Signal distortion in optical wave guides: Group delay, material dispersion, waveguide dispersion and intermodal dispersion. Pulse broadening in optical fibers. Power launching in Optical fibers, Source-output pattern, Lensing schemes. Fiber-to-fiber joints: Mechanical misalignment, fiber related losses, Fiber and face preparation. Fiber splicing techniques, fiber connectors.

UNIT – V

Non linear Optics: Second harmonic generation, parametric amplification, Phase matching, parametric oscillation, Frequency up conversion, Electro optic modulation of laser beams, electro optic effect, electro optic retardation, electro optic amplitude modulation, phase modulation of light, electro optic beam deflection.

Text Books:

1. Lasers -Theory and Applications – K. Thyagarajan and A.K. Ghatak
2. Optical Fiber Communications – Gerd Keiser
3. Optical Electronics – Amnon Yariv

Reference Books:

1. Laser Fundamentals – William T. Silfvast
2. Introduction to Fiber Optics – Ajoy Ghatak and K. Thyagarajan
3. Optical Electronics – Ajoy Ghatak and K.Thyagarajan
4. Optical Electronics – J. Wilson and J.F.B. Hawkes

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Andhra University
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Syllabus

M.Sc. Physics

III SEMESTER

<u>*ODD 3 Elective- I (303)</u> <u>P 303: DIGITAL ELECTRONICS AND MICROPROCESSORS</u>

(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. To make the students learn the basics of digital electronics.
2. To Introduce the concept of digital and binary systems
3. To be able to design and analyze combinational logic circuits.
4. To be able to design and analyze sequential logic circuits.
5. To understand the basic design and implementation of digital circuits and systems.
6. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
7. To prepare students to perform the analysis and design of various digital electronic circuits.
8. Reinforce theory and techniques taught in the classroom through experiments in the laboratory.
9. To introduce students with the architecture and operation of typical microprocessors and microcontrollers.
10. To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
11. To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

Learning Outcomes:

At the end of the course, a student will be able to:

1. Convert different type of codes and number systems which are used in digital communication and computer systems.

2. Employ the codes and number systems converting circuits and Compare different types of logic families which are the basic unit of different types of logic gates in the domain of economy, performance and efficiency.

3. Analyze different types of digital electronic circuit using various mapping and logical tools and know the techniques to prepare the most simplified circuit using various mapping and mathematical methods.

4. Design different types of with and without memory element digital electronic circuits for particular operation, within the realm of economic, performance, efficiency, user friendly and environmental constraints.

5. Apply the fundamental knowledge of analog and digital electronics to get different types analog to digitalized signal and vice-versa converters in real world with different changing circumstances.

6. Assess the nomenclature and technology in the area of memory devices and apply the memory devices in different types of digital circuits for real world application.

7. Learn microprocessor with the help of basic knowledge of digital electronics.

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DEPT. OF PHYSICS
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VISAKHAPATNAM

8. Understand the fundamentals of digital electronics and microprocessor and microcontroller, which will be useful to them in understanding the concept behind Digital India.
9. Assess and solve basic binary math operations using the microprocessor and explain the Microprocessor's and Microcontroller's internal architecture and its operation within the area of manufacturing and performance.
10. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
11. Compare accepted standards and guidelines to select appropriate Microprocessor (8085) and Microcontroller (8051) to meet specified performance requirements.
12. Analyze assembly language programs, select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.
13. Design electrical circuitry to the Microprocessor I/O ports in order to interface the processor to external devices.
14. Evaluate assembly language programs and download the machine code that will provide solutions to real-time control problems.

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UNIT- I: Combinational Logic Circuits: **(i)** Simplification of Boolean Expressions: Algebraic method, Karnaugh Map method, **(ii)** Encoder, decoder, Multiplexer, Demultiplexer, Design of Adders and Subtractors, IC parallel adder. **(iii)** Applications of Boolean algebra: Magnitude Comparator, Parity generator, Checker, Code converter, Seven-segment decoder/ Driver display.

UNIT – II: Sequential Logic Circuits: (i) Flip-Flops: NAND latch, NOR latch, , Clocked S-C flip-flop, J-K flip-flop, D flip-flop, Asynchronous inputs **(ii)** Counters: Asynchronous counters (Ripple), Counters with MOD number < 2^N, Asynchronous down counter, Synchronous counters, Up-down counter **(iii)** Registers: Shift Register, Integrated Circuit registers, Parallel In Parallel Out (PIPO), SISO, SIPO, PISO. **(iv)** Applications of Counters: Frequency Counter.
(v) A/D and D/A Converter Circuits: D/A Converter, Linear weighted and ladder type, an integrated circuit DAC; Analog-to-Digital Conversion, Digital Ramp ADC, Successive Approximation Method, Sample and Hold Circuit, Digital Voltmeter.

UNIT – III: Intel 8085 Microprocessor (i) Architecture, Functional diagram, Pin description, Timing Diagram of Read Cycle, Timing diagram of write Cycle **(ii)** Programming the 8085 Microprocessor: Addressing Methods, Instruction set, Assembly language programming **(iii)** Examples of Assembly Language Programming: Addition/Subtraction of two 8-bit/16-bit numbers, Addition of two decimal numbers, Sum of series of 8-bit numbers, Largest element in the array, Multiple byte addition, Delay sub-routine.

UNIT – IV: Data Transfer Techniques: (i) Serial transfer, Parallel transfer, Synchronous, Asynchronous, DMA transfer, Interrupt driven Data transfer **(ii)** 8085 Interfacing: I/O Interfacing: Programmable Peripheral Interfacing, 8255, Programmable Peripheral Interval Timer 8253, Programmable Communication Interface 8251, DAC 0800 and ADC 0800 interfacing.

UNIT – V: 8051 Microcontroller: (i) 8051 Internal Architecture, Register Structure, I/O pins, Memory Organization, 8051 Addressing modes, 8051 Assembly Language Programming Tools, 8051 Instruction set, **(ii)** Data Transfer Instructions, Arithmetic instructions, Logical instructions **(iii)** Boolean Variable Manipulation Instructions-Bit Addressability, Single-Bit instructions, Program Branching instructions-Jump, Loop, and Call instructions, Rotate Instructions, Stack Pointer.

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DEPT. OF PHYSICS
AU College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

Text Books:

1. Digital Systems – Principles and applications –Ronald J. Tocci
2. Fundamentals of Microprocessors & Microcomputers - B. RAM
3. Digital principles and applications - A. P. Malvino & Donald P. Leech
4. Micro Controllers: Theory and Applications - Ajay V. Deshmukh
5. Micro Controllers – Rajkamal
6. Micro Controllers – Kenneth J Ayala

Reference Books:

1. Digital Electronics – William H Gothmann
2. Digital Fundamentals – Thomas L. Floyd
3. Fundamentals of Digital Circuits - A. Ananda Kumar
4. Introduction to Microprocessors for Engineers and Scientist - P.K.Ghosh and P.R.Sridhar
5. Microprocessor Architecture, Programming and Applications with the 8085 /8080A - Ramesh. S. Gaonkar
6. 8051 Microcontroller and Embedded systems - Mahammad Ali Mazidi & Janice GillispieMazidi
7. 8051 Microcontroller – Mike Predko

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Andhra University
VISAKHAPATNAM-530 003

Syllabus

M.Sc. Physics

III SEMESTER

*ODD 3 Elective- II P 303 – PRINCIPLES OF ULTRASONICS

(Effective from 2021-22 Admitted Batches)

Course Objectives: The course gives introduction of ultrasonics and its properties and production of ultrasonics by various methods. The course also describes the propagation of ultrasonics in different media and describes the measurement of ultrasonic velocities using various techniques. The course discusses different methods in non-destructive testing and its applications. The course discusses the applications of both low and high intensity ultrasonics in various fields.

Learning Outcomes : Students will be able to know the concept of different ranges of frequencies and ultrasonic waves and its production and properties by various methods. They also able to learn the concept of propagation of ultrasonic waves in different liquid media with binary and ternary mixtures. They will be able to know the concept viscoelasticity. They able to measure ultrasonic velocities and absorption coefficients in liquids by using various instruments. They able to understand non-destructive testing methods and applications and learn applications of low and high intensities ultrasonic in the medical field, imaging, process control.

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UNIT I:

Introduction of ultrasonics, basic principles of ultrasonic waves, properties, production of ultrasonics i. Magnetostriction method. ii. Piezoelectric method. Detection of ultrasonic waves, basic design of ultrasonic transducer.

UNIT II:

Propagation of ultrasonics velocity of plane wave in a medium, absorption of plane longitudinal waves in gases and low viscosity liquids where relaxation effects are absent.

Viscoelasticity: Viscoelasticity of a medium, molecular picture of viscoelastic relaxation, propagation of shear wave in a visco elastic medium, The Maxwell model.

UNIT III:

Measurements of ultrasonic velocities and absorption coefficients in liquids.

i.DSA 5000 M(Density and Sound VelocityMeter) ii.The ultrasonic Interferometer iii. Pulse-echo technique iv.Optical diffraction method, Cavitation process, cleaning technique.

UNIT 1V:

Non-destructive testing, different methods in non-destructive testing and applications of ultrasonic waves using non-destructive testing, flaw detection, applications of ultrasonics in medical field.

UNIT V:

Application of ultrasonics (low and high intensities) in mechanical, chemical and metallurgical area.Ultrasonic imaging, process control and applications.

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DEPT. OF PHYSICS
AVD College of Science & Technology
Andhra University
VISAKHAPATNAM 530 003

Reference Books:

1. Fundamental of ultrasonics - Jock Blitz
2. Ultrasonics- the low and high intensity applications - Dale Ensminger
3. Engineering Physics -1 - Dr. D. Tirupati Naidu & M. Veeranjaneyulu
4. Molecular Acoustics - A. J. Matheson

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DEPT. OF
College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

Syllabus

M.Sc. Physics

IV SEMESTER

***Odd 3 Elective I* P 304: MATERIALS SCIENCE**
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. Give basic knowledge of science behind materials & physical metallurgy.
2. Introduce the concept of structure property relations.
3. To have fundamental understanding of materials behavior, or conceived, designed, and realized useful products and technology platforms within realistic engineering constraints, as demonstrated by, for example, development of new materials, improvement of existing materials, development of new materials processing, or development of new analytical tools and core competence in materials.
4. Lay the groundwork for studies in mechanical behavior of materials & applications of recent materials.
5. Are valued not only for understanding the structure and composition of materials, but equally for analytical and creative abilities fostered by a broad engineering,
6. To work effectively in multidisciplinary areas of materials science to solve complex problems.
7. Ability to deal with business and non-technical aspects of materials science & engineering.
8. Develop intuitive understanding of the subject to present a wealth of real world engineering examples to give students a feel of how material science is useful in engineering practices.
9. Analyze the Structure of materials at different levels, basic concepts of crystalline materials etc. understanding.
10. Concept of mechanical behavior of materials and calculations of same using appropriate equations understanding.
11. Explain the concept of phase & phase diagram & understand the basic terminologies associated with metallurgy understanding.
12. Construction and identification of phase diagrams and reactions Understanding,
13. Understand and suggest the heat treatment process & types.
14. Significance of properties.
15. Explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials, etc.

Learning Outcomes:

1) An ability to apply knowledge of mathematics, science and engineering to materials issues.
2) An ability to design and conduct experiments and critically analyze and interpret data.
3) An ability to design a process and/or material system to achieve specific requirements within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

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P G Board of Studies (Physics)
DEPT. OF PHYSICS
A.U. College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

4) An ability to work effectively in multidisciplinary teams, be conversant in languages of other fields, and provide leadership to such teams.
5) An ability to identify, formulates, and solves science & engineering problems.
6) An understanding of professional and ethical responsibility.
7) An ability to communicate effectively.
8) The broad education necessary to understand the impact of science & engineering solutions in a global, economic, environmental, and societal context.
9) A recognition of the need for, and an ability to engage in, lifelong learning.
10) A knowledge of contemporary issues in science, engineering and society.
11) An ability to use modern techniques, skills, and science & engineering tools appropriate to materials research.
12) An integrated understanding of structure, properties, processing and performance of materials systems.

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UNIT-I
Structure of Materials:
Concept of amorphous, single crystal and polycrystalline materials, defects in crystalline materials, point, line and surface imperfections, vacancies, interstitials, dislocations; grain boundaries, twins, stacking faults.

UNIT-II
Classification of Materials:
Metals and Alloys: alloying nature, concept of formation of alloys, types of alloys, solid solutions, Nd-Fe-B alloy, AlNiCo alloys
Ceramics: introduction, classification, oxides, carbides, nitrides, or silicates of metals, glass, porcelain, ferrites
Polymers: structure of polymers, strengthening of polymers, crystallization and glass formation, types of polymers, nylon, polyethylene, polyvinyl chloride, rubber
Composites: definition, classification, types of matrices and reinforcements, metal-matrix composites, polymer-matrix composites, and ceramic-matrix composites, composite strengths, particles, whiskers and fibers as reinforcements
Semiconductors: concept of doping, simple and compound semiconductors, silicon, germanium, gallium arsenide, amorphous silicon, oxide semiconductors.

UNIT-III
Processing of Materials:
Heat treatment of alloys; annealing, re-crystallization and grain growth, preparation of ceramic powders, solid-state reaction, sintering; thin film deposition, evaporation and sputtering techniques, and chemical vapor deposition.

UNIT-IV
Properties of Materials:
Mechanical Properties: stress, strain, elastic properties, deformation- elasticity, hardness, stress-strain response (elastic, inelastic and plastic deformation)
Electrical Properties: dielectric polarization, mechanism of polarization, dielectric constant, dielectric losses and breakdown, piezoelectric and ferroelectric behavior, electrical conduction in semiconductors, temperature dependence of electrical conductivity
Magnetic Properties: classification of magnetic materials, ferromagnetism, ferrimagnetism, antiferromagnetism and superparamagnetism, domain theory and hysteresis, magnetization processes in terms of domain theory, Domain wall, properties of domain walls and domain wall motion, magnetic anisotropy.

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DEPT. OF PHYSICS
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UNIT-V

Applications of Materials:

Metals and Alloys: Nd-Fe-B, AlNiCo alloys,

Ceramics: soft and hard ferrites, ferroelectric and piezoelectric materials

Polymers: plastic fibers, coating adhesives, biomedical applications,

Composites: aircraft engineering-space hardware, wind turbine, marine craft-space structure, applications in surgery.

Text & Reference Books:

Composite Materials	Krishnan K. Chawla
Materials Science and Engineering	V Raghavan
Electronic Processes in Materials	L.W. Azaroff and J.J.Brophy
Introduction to Solid State Physics	C.Kittel
Science of Engineering Materials	C.M.Srivastava and C. Srinivasan
Solid State Physics	A.J.Dekkar
Solid State Physics	S.O.Pillai
Solid State Devices and Materials	Ben.G Streetman

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VISAKHAPATNAM-530 003

M.Sc. Physics

III SEMESTER

***Odd 3 Elective-II* P 304:- RADAR SYSTEMS AND SATELLITE COMMUNICATIONS**

(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. To learn about Radar systems, Design and Tracking of Radars.
2. To study about MTI and Pulsed Radar Systems.
3. To study Satellite basics and Satellite communication systems.
4. To learn about satellite link design and multiple access techniques.

Learning Outcomes:

On completion of the course, students will be able to

1) Describe the working principle of different RADAR systems and their applications.
2) Identify the various RADAR systems in existence, specify their applications and limitations, and explain the principles of how they work.
3) Describe the most commonly used techniques in processing RADAR signals.
4) Recognize and describe the various technologies used in the design of RADAR systems: antennas, transmitters, duplexers, data display screens, etc.
5) Design simple radar systems and the associated signal processing, at block diagram level.
6) Understand the Satellite fundamentals and types of satellite.
7) Explain the working of a Satellite communication system and its other subsystems.
8) Know the applications of Satellites in different areas.
9) Describe the principles of radio navigation systems (including secondary radar and GPS).
10) Identify the fundamentals of orbital mechanics, the characteristics of common orbits used by communications and other satellites, and be able to discuss launch methods and technologies.
11) Describe the systems required by a communications satellite to function and the trade-offs and limitations encountered in the design of a communications satellite system.
12) Describe the radio propagation channel for Earth station to satellite and satellite to satellite communications links, and the basics of designing antenna systems to accommodate the needs of a particular satellite system.
13) Analyze an accurate link budget for a satellite or other wireless communications link.

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DEPT. OF PHYSICS
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Andhra University
VISAKHAPATNAM-530 003

Unit – I:

Radar Systems: Fundamental – A simple RADAR – overview of frequencies – Antenna gain Radar Equation – Accuracy and Resolution – Integration time and the Doppler shift

Designing a surveillance radar – Radar and surveillance – Antenna beam – width consideration – pulse repetition frequency – unambiguous range and velocity – pulse length and sampling – radar cross section – clutter noise

Tracking Radar – Sequential lobbing – conical scanning – Mono pulse Radar – Tracking accuracy and Process – Frequency Agility – Radar guidance ,Signal and data processing.

UNIT – II:

MTI and Pulse doppler Radar: Introduction to Doppler and MTI radar, MTI and pulse radar, Doppler frequency shift, simple CW Doppler Radar, Sweep to sweep subtraction and delay line cancellers, MTI radar block diagram Radar Antenna – Antenna parameters – Antenna Radiation Pattern and aperture distribution – Parabolic reflector – cosecant squared antenna pattern .

UNIT – III:

Satellite Communication: Satellite System – Historical development of satellites – communication satellite systems – communication satellites – orbiting satellites – satellite frequency bands – satellite multiple access formats, Satellite orbits and inclination – Look angles, orbital perturbations, space craft and its subsystems – attitude and orbit control system – Telemetry, Tracking and Command – Power system – Transponder – Reliability and space qualification – launch vehicles

UNIT – IV:

Satellite Link Design: Introduction, General Link Design Equation, System Noise Temperature, C/N and G/T Ratios, Uplink Design, Downlink Design, Downlink Rain Fade Margin, Complete Link Design, Satellite Link Design with Specified (C/N), Dependence of (C/N) Ratio on Earth Station Parameters .

UNIT V:

Multiple Access Techniques – Time division multiple access – Frequency division multiple access – Code division multiple access – Space domain multiple access, Earth Station technology – Subsystem of an earth station – Transmitter – Receiver, Tracking and pointing – Small earth station – different types of earth stations – Frequency coordination – Basic principles of special communication satellites – INMARSAT, VSAT, GPS, RADARSAT, INTELSAT.

Text Books:

1. Understanding Radar Systems – Simon Kingsley and Shaun Quegan.
2. Satellite Communication – Robert M. Gagliardi
3. Satellite Communication – Monojit Mitra

Reference Books

1. Introduction to Radar Systems – MI Skolnik
2. Satellite communications – Timothy Pratt,Carles Bostian and Jeremy Allnutt

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DEPT. OF PHYSICS
AVD College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

SYLLABUS

M.Sc. Degree Examination
Physics
Third Semester

P 305 – Digital Electronics and Microprocessor Laboratory
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. This course will enable the students to learn the basic concepts and techniques and application of knowledge in digital electronic circuits and systems.
2. To acquire the basic knowledge of digital logic levels.
3. The learning objective of this course is to understand the concepts of digital circuits and systems with adequate introduction to both combinatorial and sequential logic circuits, such as, adders, comparator, decode counter, etc.
4. This course introduces the assembly language programming of 8085.
5. The course objective is to introduce the basic concepts of microprocessor and to develop in students the assembly language programming skills and real time applications of Microprocessor as well as microcontroller. It gives a practical training of interfacing the peripheral devices with microprocessor.
6. The objective of this laboratory is to understand various Modulation techniques in time domain and frequency domain to impart hands on experience and train the students to analyze various modulation techniques and understand their performance to comprehend various coding techniques on transmission medium in Digital communications.

Course Outcomes:

After studying this course, the students would gain enough knowledge

1. Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
2. Identify the various digital ICs and understand their operation.
3. Learn about comparator and decade counter.
4. The ability to identify and prevent various hazards and timing problems in a digital design.
5. Ability to identify basic requirements for a design application and propose a cost-effective solution.
6. The student will be able to design AM, FM, Mixer and analyze the modulation techniques.
7. Design interfacing circuits with 8085.
8. Practice different types of programming keeping in mind technical issues and evaluate possible causes of discrepancy in practical experimental observations in comparison.

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P G Board of Studies Physics
DEPT. OF PHYSICS
A.U. College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

LIST OF EXPERIMENTS

1. Adders: Half Adder, Full Adder and Parallel Adder
2. Digital Comparator (IC 7485)
3. Decade Counter (IC 7490)
4. Addition/ Subtraction of 8-bit numbers using 8085.
5. Largest number in an Array, Sum of Series of 8 – bit and Sum of two 16 – bit numbers
6. Interfacing of 8255 PPI: Generation of Square Wave and Rectangular Wave
7. Amplitude Modulation
8. Butterworth First Order Low Pass and High Pass Filters
9. Mixer

Reference Books:

1. Digital Principles and Applications - Malvino and Leach
2. Digital Fundamentals - Thomas L Floyd
3. Digital Logic and Computer Design - M. Morris Mano
4. Digital Design - M. Morris Mano
5. Advanced Microprocessors & Peripherals - A K Ray and K M Bhurchandi
6. 8051 microcontroller and embedded systems - M A Mazidi and J G Mazidi
7. An introduction to analog and digital communications – Simon Haykin
8. Modern Analog and Digital Communication Systems – B P Lathi
9. Basic *Electronics: A Text-Lab Manual* - Paul Zbar & Albert P Malvino
10. Experiments in Electronics - S V Subrahmanyam

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DEPT. OF PHYSICS
AVD College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

SYLLABUS

M.Sc. Degree Examination
Physics
Third Semester

P 306 – Solid State Physics Laboratory
(Effective from the admitted batch of 2021-2022-CBCS)

Course Objectives:

1. This course will concentrate on experiments in solid state physics covering a broad range of topics representative of the field.
2. This course is an upper division lab with some focus on solid state physics.
3. This course integrates theory of Solid-State Physics with experimental demonstrations in the Research Physics Lab.
4. This course will provide a valuable theoretical introduction and an overview of the fundamental applications of the physics of solids.
5. This course includes theoretical description of crystal and electronic structure, lattice dynamics, and properties of different materials (metals, semiconductors, dielectrics, magnetic material), based on the classical and quantum physics principles.
6. However, the student is expected to master the topic of the experiment in depth and produce an experiment procedure before attempting data collection.
7. After the experiment is completed, each student will write a record that includes experimental results, and analysis and discussion of these results.
8. Several advanced experiments like X-ray diffraction, Raman Scattering, etc., will be carried out in the Research Physics Lab followed by their theoretical discussion.

Course Outcomes:

1. Student will be able to observe and analyze physical data relevant to some of the experiments in solid state physics.
2. Provide students with a thorough understanding of the basic concepts of physics and the methods scientists use to explore natural phenomena, including observation, hypothesis development, measurement and data collection, experimentation, evaluation of evidence, and employment of mathematical analysis.
3. Interpreting results through analyzing data and analysis, writing record.
4. Learning more advanced physics topics, not encountered at the introductory level.
5. Students are expected to develop a clear concept of the crystal classes and symmetries.
6. Students will be able to calculate the Braggs conditions for X-ray diffraction in crystals and will calculate the conditions for allowed and forbidden reflections in crystals.
7. Students will learn the basics of the phonons in crystals.
8. Students will become familiar with the free-electron model for metals and use the concept of Fermi energy and Fermi temperature.
9. Basic concepts of the band theory of solids will be given to Students, who will be able to predict the properties of materials and compounds.

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DEPT. OF PHYSICS
IVD College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

LIST OF EXPERIMENTS

1. Hall Effect: Determination of Hall coefficient and estimation of carrier concentration and its mobility
2. Coupled Oscillations: Study of the frequencies of normal modes of two coupled pendulums, strength of the coupling constant
3. X-ray Diffraction: Study of the X-ray diffraction and determination of lattice parameter and the number of atoms per unit cell in NaCl and KCL
4. Four –probe: Determination of energy gap of a semiconductor using four-probe method
5. Magneto resistance: Observe the magneto resistance of a semiconductor using four – probe arrangement
6. Thermo electric power: Calculation of Thermoelectric power and carrier concentration of a Ferrite material
7. Lattice Dynamics: Study of the Phonon dispersion characteristics for mono atomic lattice
8. Measurement of ultrasonic velocity in binary liquid mixtures at different temperatures using ultrasonic interferometer at a fixed frequency.

Reference Books:

1) Solid State Electronic Devices - Ben G. Streetman and Sanjay Kumar Banerjee
2) Semiconductor Physics and Devices - Donald A. Neamen and Dhrubes Biswas
3) Physics for Scientists and Engineers - Raymond A. Serway and John W. Jewett
4) Introduction to Modern Solid-State Physics - Yuri M. Galperin
5) Solid State Physics – Laboratory Manual – Lucian ION
6) Advanced Practical Physics - B.L. Worsnop & H.T. Flint

M.Sc. Physics Programme

Matrix Mapping of PO's vs CO's

(THIRD SEMSTER)

P 301: SOLID STATE PHYSICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2	✓				
PO-3		✓			
PO-4					
PO-5					

P 302: LASERS & FIBER OPTICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1					
PO-2	✓				
PO-3			✓		
PO-4					
PO-5					✓

P 303: ELECTIVE PAPER: 1. DIGITAL ELECTRONICS AND MICROPROCESSORS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1					
PO-2		✓			
PO-3			✓		
PO-4				✓	
PO-5					✓

P 303: ELECTIVE PAPER: 2. PRINCIPLES OF ULTRASONICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3					
PO-4				✓	
PO-5					

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DEPT. OF PHYSICS
AU College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

P 304: ELECTIVE PAPER: 1. MATERIAL SCIENCE

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓			
PO-3			✓		
PO-4					
PO-5				✓	

P 304: ELECTIVE PAPER:

2. RADAR SYSTEMS AND SATELLITE COMMUNICATIONS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2					
PO-3		✓	✓		
PO-4				✓	
PO-5					

P 305: DIGITAL ELECTRONICS & MICROPROCESSOR LAB

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1		✓			
PO-2			✓		
PO-3					
PO-4	✓				
PO-5				✓	

P 306: SOLID STATE PHYSICS LAB

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2	✓				
PO-3					
PO-4		✓			
PO-5					

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Andhra University
VISAKHAPATNAM-530 003

M.Sc. PHYSICS

SYLLABUS & MODEL QUESTION PAPERS

4th SEMESTER

(Effective from 2021-22 Admitted Batches)

M.Sc. Physics

IV SEMESTER

P 401 ADVANCED QUANTUM MECHANICS
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) Elementary quantum mechanics is taught in the first semester and after building the foundation, advanced quantum mechanics is taught in the final semester.
2) To understand the concepts of the time-dependent perturbation theory and their applications to physical situations.
3) To understand the basics of scattering theory.
4) To understand the quantum dynamics through Schrödinger picture and Heisenberg picture.
5) To understand linear vector spaces in quantum mechanics.
6) To understand the relativistic quantum mechanics.
7) To understand the concept of field quantization, this is very much useful in the area of quantum computing.

Learning Outcomes:

1) Develop knowledge and understanding of the concept that quantum states live in a vector space.
2) Develop a knowledge and understanding of the meaning of measurement.
3) Elate this abstract formulation to wave and matrix mechanics.
4) Develop a knowledge and understanding of perturbation theory, level splitting, and radiative transitions.
5) Develop a knowledge and understanding of the relation between conservation laws and symmetries.
6) Develop a knowledge and understanding of the role of angular momentum in atomic and nuclear physics.
7) Develop a knowledge and understanding of the scattering matrix and partial wave analysis.
8) Solve quantum mechanics problems.
9) Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.
10) Competent to take up research in frontier areas like quantum information, quantum computation, quantum entanglement, quantum fields and quantum gravity besides quantum mechanics for learning and appreciating phenomena in several other disciplines like condensed matter, statistical mechanics and modern optics.

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DEPT. OF PHYSICS
IVD College of Science & Technology
Andhra University
VISAKHAPATNAM-530 003

UNIT - I

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. *(Merzbacher Sec. 14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7)*

UNIT - II

Quantum Dynamics:

The equation of motion, Quantization postulates, canonical quantization, Constants of motion and invariance properties. Heisenberg picture. Harmonic Oscillator.

(Merzbacher. Sec. 15.1, 15.2, 15.3, 15.4, 15.6, 15.7)

UNIT - III

Development of time-dependent perturbation theory. The golden rule for constant transistion rates. *(Merzbacher. Chapter. 18)*

Addition of two angular momenta. Tensor operators.

Wigner-Eckart theorem. Matrix elements of vector operators. Parity and time reversal symmetries.

(Merzbacher. Section. 16.6, 16.8, 16.10, 16.11)

UNIT - IV

Scattering:

Concept of differential cross-section. Scattering of a wave packet, Born approximation Partial waves and phase shift analysis. *(Merzbacher. Section. 11.1, 11.2, 11.4, 11.5)*

Relativistic Quantum Mechanics:

Klein – Gordon equation, Dirac equation for a free particle, Equation of continuity, Spin of a Dirac particle, Solutions of free particle Dirac equation, Negative energy states and hole theory. (*B S Rajput*)

UNIT - V

Field of Quantization:

Lagrangian formulation of field, Hamiltonian formulation of field, Poisson bracket formulation of field variables, quantum equation for the field, field with more than one component, quantization of the non-relativistic Schrodinger equation, N representation, system of fermions.(*G S Chaddha; V K Thankappan*).

Text Books:

Quantum Mechanics - E. Merzbacher

Reference Books:

1. Quantum Mechanics - G. S. Chaddha
2. Quantum Mechanics - R.D. Ratna Raju
3. Quantum Mechanics - V. K. Thankappan
4. Quantum Mechanics - S. Biswas
5. Quantum Mechanics - Nouredine Zettili
6. Advanced Quantum Mechanics – B S Rajput
7. Advanced Quantum Mechanics - J J Sakurai

Syllabus

M.Sc. Physics

IV SEMESTER

P 402: PROPERTIES AND CHARACTERIZATION OF MATERIALS

(Effective from 2021-22 Admitted Batches)

Course Objectives:

This course presents the properties and characterization of materials, emphasizing on surface, interface and microanalysis, using the underlying analytical techniques as a unifying framework, carrying through to illustrative applications.

To provide with the knowledge to: define a characterization strategy appropriate to the problem/situation - select the most appropriate/promising techniques - analyze and interpret the results – utilizing interpretation/simulation tools - develop state of the art expertise – hardware, software, systems integration - understand new techniques as they emerge.

Learning Outcomes:

The course provides some knowledge that is state-of-the-art techniques in the study of properties and characterization of materials.

A further benefit of the course is to provide students a fundamental and practical understanding of the interaction of particle radiation with condensed matter.

This knowledge finds applications in optoelectronics, microelectronics and, in general, all aspects of materials processing and characterization.

***

UNIT-I: Structural Characterization:

Properties: Lattice parameter, crystallite size

Characterization: X-ray powder diffraction, Neutron diffraction, instrumentation, specimen preparation, ASTM catalogue of Materials identification, Phase identification, intensity of diffracted peaks, indexing of x-ray diffraction peaks, data analysis and interpretation, Rietveld refinement technique, Williamson-Hall plots, determination of crystal structure, lattice parameter.

UNIT-II: Microstructural Characterization:

Properties: Particle size, grain size, transmissivity, absorptivity, photoconductivity, polarization

Characterization: Transmission electron microscopy (TEM), basic principle, brief idea of set up, specimen preparation, image formation, particle size determination.

Scanning electron microscopy (SEM), Instrumentation basics, specimen preparation, imaging modes, grain size estimation.

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VISAKHAPATNAM 530 003

Optical microscopy, instrumentation, specimen preparation, imaging modes, applications, limitations.

UNIT-III: Electrical Characterization:

Properties: DC and AC conductivity, dielectric properties-dielectric constant, dielectric loss, dielectric strength and breakdown.

Characterization: Two-probe, four probe methods for resistivity measurement, P-E loops, Hall Effect experiment, dielectric characterization using impedance analyzer.

UNIT-IV: Magnetic Characterization:

Properties: Hysteresis loop, initial permeability, saturation magnetization, coercivity, remnant magnetization, magnetic domains, magnetic anisotropy, Curie temperature.

Characterization: Vibration sample magnetometer, SQUID magnetometer, M-H hysteresis loops, AC magnetic susceptibility.

UNIT-V: Thermal Characterization:

Properties: Heat capacity, thermal expansion, thermal conductivity, and thermoelectricity

Characterization: Differential thermal analysis (DTA), Differential Scanning Calorimeter (DSC), Thermo gravimetric analysis (TGA), principle, instrumentation, experimental parameters, data analysis and interpretation.

Text & Reference Books:

1. B. D. Cullity and S. R. Stock, "Elements of X-ray Diffraction", Third Edition, Prentice Hall Inc., New Jersey, 2001.
2. Characterization of Materials, (Volumes 1 & 2) Elton N. Kaufmann, John Wiley and Sons.
3. Materials Characterization, Introduction to Microscopic and Spectroscopic Methods by Yang Leng, JohnWiley & Sons (Asia) Pvt Ltd.
4. Materials Characterization - S. Sankaran and Viajaya Agarwal
5. Advanced Characterization Techniques - K.Biswas and Gurao
6. S. Zhang, L. Li and A. Kumar, "Materials Characterization Techniques", CRC Press, Boca Raton, 2008.

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M.Sc. Physics

IV SEMESTER

***Even 4 Elective 1* P 403: NANO MATERIALS**
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) Understand the influence of dimensionality of the object at nano scale on their properties.
2) Understand the nano material synthesis using Physical methods, mechanical – ball milling, melt mixing, evaporation, ion sputtering, laser ablation, chemical vapor deposition, chemical methods: sol-gel techniques.
3) Understand the size and shape controlled synthesis of nano materials and their future applications in industry.
4) Understand the Structural characterization using XRD, TEM, HRTEM, FTIR, X-ray Photoelectron Spectroscopy.
5) Understand the Surface characterization using SEM, AFM, TEM, EDAX, VSM.
6) Understand the hysteresis, saturation magnetization, magnetic permeability; Electrical conductivity and permittivity.
7) Understand the structure of diamond, graphite, graphene, fullerenes, CNTs
8) Understand the electronic and magnetic properties and applications of CNTs.
9) Understand the Magnetic nano particles, iron oxide and ferrite nano particles and their characteristics.
10) Understand the super paramagnetism, saturation magnetization, MRI contrast agents, drug delivery, and magnetic hyperthermia applications.

Learning Outcomes:

Students will have achieved the ability to:

1. develop a fundamental knowledge of nano materials.
2. demonstrate an understanding of the properties of materials with strong dependence on size.
3. explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at nano scale.
4. choose appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape and surface properties.
5. correlate properties of nanostructures with their shape and surface characteristics.
6. demonstrate an understanding of approaches to nano materials characterization.
7. appreciate enhanced sensitivity of nano material based sensors and their novel applications in industry.

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UNIT I: Fundamentals:

Feynman's vision, nanotechnology and nano science, history of nano materials, concept of nanoparticles, size dependent properties, length scales, classification of nano materials, zero, one, two and three dimensional nanostructures, quantum dots, nano wires, ultra-thin films, surface to volume ratio, fraction of surface atoms, quantum size effect in nanoparticles, interdisciplinary nature of nanotechnology.

UNIT II: Synthesis:

Distinction between top down and bottom up approaches, Physical methods, mechanical – ball milling, melt mixing, evaporation, ion sputtering, laser ablation, chemical vapor deposition, chemical methods: sol-gel technique, precipitation method and combustion synthesis, colloidal synthesis, hydrothermal synthesis and reverse micelles.

UNIT-III: Characterization:

Structural characterization: X-ray diffraction, Transmission Electron microscopy, HRTEM, FTIR, X-ray Photoelectron Spectroscopy; Surface characterization: scanning electron microscopy, atomic force microscopy, Tunneling electron microscopy; EDAX, Vibration sample magnetometer-hysteresis, saturation magnetization, magnetic permeability; Electrical conductivity and permittivity.

UNIT IV: Fullerenes and Carbon Nanotubes (CNTs):

Diamond, graphite, graphene, fullerenes, structure of fullerene, fullerene properties, types of fullerene, synthesis of C60, use of fullerenes, history of the discovery of the CNTs, structures of CNTs, single-walled and multi-walled carbon nano tubes, synthesis of CNTs, mechanical strength of CNTs, electronic properties of CNTs, magnetic properties of CNTs, applications of CNTs.

UNIT-V: Nanomagnetism:

Magnetic nanoparticles- iron oxide and ferrite nanoparticles, characteristics- saturation magnetization, single domain, particle and grain size, super paramagnetism – super paramagnetic relaxation and Neel relaxation time, blocking temperature, core-shell structures, MRI contrast agents, drug delivery, magnetic hyperthermia applications.

Text & Reference Books:

1. K. J. Klabunde and R.M. Richards (Eds.), Nanoscale Materials in Chemistry, 2nd Edn., John Wiley & Sons, 2009.
2. T. Pradeep, Nano: The Essentials, McGraw-Hill (India) Pvt Limited, 2008.
3. Bharat Bhushan, (Ed.), Handbook of Nanotechnology, Springer, 2007.
4. Carl C. Koch (Ed.), Nanostructured Materials: Processing Properties and Applications, William Andrew Inc., 2007.
5. Anke Krueger, Carbon Materials and Nanotechnology, Wiley-VCH Verlag GmbH & Co. KGaA, 2010
6. Cao, G., Nanostructures and Nanomaterials Synthesis, Properties, and Applications, Imperial College Press, 2004
7. Goddard III W.A., et. al.,(Ed.), Handbook of Nanoscience, Engineering, and Technology, Taylor & Francis Group, 2007.
8. B.P.S. Chauhan (Ed), Hybrid Nanomaterials: Synthesis, Characterization, and Applications, Wiley-VCH Verlag GmbH, 2011.
9. Challa S. S. R. Kumar (Ed.) Biomimetic and Bioinspired Nanomaterials, Wiley-VCH Verlag GmbH, 2010

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10. Graphene, Carbon Nanotubes, and Nanostructures: Techniques and Applications, James E. Morris, Krzysztof Iniewski, CRC Press, 2013
11. Carbon Nanotubes and Related Structures: Synthesis, Characterization and Applications, Edited by Dirk M. Guldi, Nazario Martín, Wiley-VCH Verlag, 2010
12. Carbon Nanotubes: Basic Concepts and Physical Properties, Stephanie Reich, Christian Thomsen, Janina Maultzsch, Wiley-VCH Verlag, 2004
13. Physical Properties of Carbon Nanotubes, R Saito, G Dresselhaus, M S Dresselhaus, World Scientific, 1998
14. Carbon Nanotubes: Synthesis, Structure, Properties, and Applications, Edited by M. S. Dresselhaus,G. Dresselhaus, P. Avouris, Springer-Verlag, 2000
15. Nanostructured Magnetic Materials and their Applications, Ed. D. Shi, B. Aktas, L. Pust, F. Mikailov, Springer , 2002, ISBN: 9783540368724
16. Advances in Nanoscale Magnetism, Ed. B. Aktas, F. Mikailov, Springer, 2009, ISBN: 9783540698821.

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Syllabus

M.SC. PHYSICS

IV SEMESTER

Even 4 Elective II P 403: ANTENNAS

(Effective from 2021-22 Admitted Batches)

Course Objectives:

The student will learn and understand

1. Fundamental antenna parameters and numerical methods to analyze and differentiate the antennas.
2. Students will be introduced to antennas and their principle of operation.
3. Antenna analysis.
4. the principles of radiation, their basic parameters, radiation resistance, radiation pattern, polarization, reciprocity, effective radiated power, etc.
5. Understand the basic concepts and characteristics of antennas in the transmit and receive mode.
6. Understand the concepts of array antennas such as analysis and synthesis of radiation patterns.
7. Design and analyze wire antennas such as dipoles, loop antennas and Yagi-Uda arrays.
8. Understand and design broadband antennas such as helixes, spirals, and log periodic antennas.
9. Analyze and design aperture antennas such as horns, slots, and microstrip patches.
10. Design and analyze reflector antennas using geometrical optics or physical optics techniques.
11. various types of antennas and those commonly used in communication systems.

Learning Outcomes:

On completion of this course, the students will be able to

1) Identify various basic antenna parameters.
2) Understood the language of antennas by defining the parameters.
3) Design and analyze wire and aperture antennas.
4) Design and analyze antenna arrays.
5) Analyze radiation patterns of antennas.
6) Evaluate antennas for given specifications.
7) Apply fundamentals to design different types antennas.
8) Illustrate techniques for antenna parameter measurements.
9) Describe the application of electromagnetic waves in free space.
10) To understand the various applications of antennas in radio wave propagation.
11) Able to solve antenna based engineering problems.

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UNIT - I

Radiation

Potential functions of electromagnetic fields. Potential function for sinusoidal oscillations. Fields radiated by an alternating current element. Power radiated by a current element and radiation resistance. Radiation from a quarter wave monopole or a half wave dipole. EM field close to an antenna and far field approximation. *(Chapter 10 in Jordan and Balmain)*

UNIT- II

Antenna Fundamentals

Definition of an antenna. Antenna properties – radiation pattern, gain, directive gain and directivity. Effective area. Antenna beam width and band width. Directional properties of dipole antennas. *(Chapter 11 in Jordan and Balmain and Chapter 2 in Kraus)*

UNIT - III

Antenna Arrays

Two element array. Linear arrays. Multiplication of patterns and binomial array. Effect of Earth on vertical patterns. Mathematical theory of linear arrays. Antenna synthesis – Tchebycheff polynomial method. Wave polarization.
(Chapter 11 and 12 in Jordan and Balmain and Chapter 4 in Kraus)

UNIT - IV

Impedance

Antenna terminal impedance. Mutual impedance between two antennas. Computation of mutual impedance. Radiation resistance by induced emf method. Reactance of an antenna. Biconcal antenna and its impedance. *(Ch 14 in Jordan and Balmain and Chapters 8.1 –8.5 in Kraus)*

UNIT - V

Frequency Independent (FI) Antennas

Frequency Independence concept. Equiangular spiral. Log Periodic (LP) antennas. Array theory of LP and FI structures. *(Chapter 15 in Jordan and Balmain and Chapter 15 in Kraus)*

Methods of excitation and Practical Antennas

Methods of excitation and stub matching and baluns. Folded dipole, loop antennas. Parasitic elements and Yagi-Uda arrays and Helical antenna.
(Chapter11.15 *in Jordan and Balmain)*

Text Books:

1. Electromagnetic waves and Radiating Systems - E. C. Jordan and K. G. Balmain
2. Antennas - J. D. Kraus

Reference Book:

1. Antenna Theory - C. A. Balanis

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M.Sc. Physics

III SEMESTER

***Even 4 Elective 1* P 404: COMMUNICATION ELECTRONICS**
(Effective from 2021-22 Admitted Batches)

Course Objectives:

1. To learn the basic wave spectra.
2. To introduce students to the basic idea of signal and system analysis and its characterization in time and frequency domain.
3. To understand the mathematical description of continuous and discrete time signals and systems.
4. To classify signals into different categories.
5. To Analyze Time Invariant systems in time transform domains.
6. To understand the concept of modulation and its needs.
7. To understand different types of AM (Analog Modulation) techniques and their principles.
8. To learn different AM systems (generation and detection).
9. To learn different types of angle modulation schemes (FM & PM), their generation and detection.
10. To understand the principles of PAM, PTM, PCM, DPCM, Delta Modulation, Digital Carrier Systems such as ASK, PSK, FSK and DPSK.
11. Analyze the noise characteristics of a communication system using different modulation schemes.

Learning Outcomes:

After the completion of the course the student will be able to:

1. Understand the application of wave spectra.
2. Understand use of transforms in analysis of signals and system in continuous and discrete time domain.
3. Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
4. Compare the performance of AM, FM and PM schemes.
5. Evaluate the performance of PCM, DPCM and DM in a digital communication system.
6. Understand the digital Line Codes, M-ary encoding, differential encoding and sampling.
7. Understand noise and its effect on AM and FM communication systems.

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Unit I:

Wave spectra: Sinusoidal wave forms, General periodic wave forms, Trigonometric Fourier series for periodic wave, Fourier coefficients, Some general properties of periodic wave forms, Exponential Fourier series, Energy signals and Fourier Transforms, properties of Fourier Transforms, Fast Fourier Transforms, Power signals.

Unit II:

CW Modulation: Amplitude Modulation (AM): Introduction, Amplitude modulation, modulation index, Frequency spectrum, Average power for sinusoidal AM, Amplitude modulator and demodulator circuits, double side band suppressed carrier (DSBSC) Modulation, Super heterodyne receiver. Single Side Band Modulation (SSB): SSB principles, Balanced Modulator, SSB generation.

Unit III:

Angle Modulation: Frequency modulation (FM), sinusoidal FM, Frequency spectrum for sinusoidal FM, frequency deviation, modulation index, Average power in sinusoidal FM, FM generation. Phase Modulation: Equivalence between PM and FM, FM detectors: Slope detector, Balanced slope detector, Foster – Sealy discriminator, Ratio detector, Amplitude limiter, FM receiver.

UNIT IV:

Pulse Modulation: Digital Line Codes: Symbols, Functional notation for pulses, Line codes and wave forms: RZ, NRZ, Polar, Unipolar, AMI, HDBn and Manchester codes, M-ary encoding, Differential Encoding, Sampling theorem, Principles of pulse Amplitude Modulation (PAM) and Pulse Time Modulation(PTM), Pulse code modulation (PCM), quantization, Nonlinear quantization, companding, differential pulse code modulation (DPCM), Delta Modulation(DM), Digital Carrier Systems: ASK, PSK, FSK and DPSK.

UNIT V:

Noise in Communication Systems: Thermal Noise, Shot Noise, Partition noise, Signal to noise ratio, Noise factor, Amplifier input noise in terms of F, Noise factor of amplifiers in cascade (Friss formula), Noise temperature, Noise in AM, Noise in FM systems. Noise in pulse modulation systems: Inter symbol interference (ISI), eye diagrams.

Text Books:

1. Electronic Communications - D. Roody & John Coolin
2. Communication Systems Analog and Digital - R P Singh & S D Sapre

Reference Books:

1. Electronic Communications Systems - G. Kennedy
2. Modern Analog & Digital Communications - B.P. Lathi

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Syllabus

M.Sc. Physics

IV SEMESTER

***Even 4 Elective – II* P 404: IONOSPHERIC RADIO WAVE PROPAGATION AND SOUNDING TECHNIQUES**

(Effective from 2021-22 Admitted Batches)

Course Objectives:

1) This course examines the propagation characteristics of radio waves in ionized and magnetized gases and applications of radio waves in Earth's near space environment.
2) To learn the propagation effects and applications examined include dispersion and attenuation, reflections and refractions (in plane and spherical stratified geometries).
3) To understand a short description of the Earth's ionosphere and its variability,
4) To understand the basic theory of radio waves.
5) To learn the factors involved in the propagation of Radio Waves.
6) To understand the Ionosphere and its effects on radio waves.
7) To understand the mechanism of Ionospheric propagation.
8) To understand the dispersion theory of radio wave propagation in an anisotropic and isotropic media.
9) To derive the refractive index for a collisionless plasma and recognize propagation and evanescence conditions in ionospheric plasma in terms of plasma and radiowave frequencies.
10) To understand the magneto-ionic propagation effects in the ionosphere system with a special focus on near-Earth space environment including the neutral (un-ionized) atmosphere, ionosphere, magnetosphere, and solar wind.
11) To have a focus on the underlying physics of near-Earth space environment giving rise to these propagation effects.
12) To learn the Absorption — in weakly collision plasmas occupying the lower ionosphere.
13) To learn the radio wave propagation in the ionosphere and Appleton-Hartree equation.
14) To understand the ray paths, skip distance, Critical frequency, MUF.
15) To calculate phase and group velocities from specified dispersion relations and/or refractive index formulae, and perform group path and phase path calculations in homogeneous dispersive media.
16) To learn the ionospheric sounding and ionosonde and principle of a riometer.
17) ion acoustic and Langmuir waves, incoherent scatter spectrum shape, and plasma parameter estimation from spectra.

Learning Outcomes:

After the completion of the course the student will be able to:

1) know the ionospheric regions.
2) study theoretically how radio waves propagate in the ionosphere.
3) understand the average morphology and causes of formation of the ionosphere.

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4) perform ionospheric ray tracing calculations using the secant Law, Breit and Tuve Theorem, Martyn's Theorem to determine sky wave link parameters including the skip zone and maximum usable frequency (MUF).
5) understand the damping effect of electron collisions in the D-region ionosphere on radiowave propagation of radiowaves.
6) understand the basic principles of ionospheric sounding measurements and calculate virtual height versus frequency curves (ionograms) given an ionospheric electron density profile. describe how the scientific radiowave-based instruments, like the ionosonde, riometer and incoherent scatter radar, work and utilize the knowledge in space physics research.

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UNIT – I: Neutral Atmosphere Structure and Composition:
Nomenclature - Thermal structure of the atmosphere, Hydrostatic equation of the atmospheric structure, scale height and geopotential height, Exosphere.
Atmospheric composition, Dissociation and diffusive separation, thermosphere composition, Heat balance and temperature profile of thermosphere.
(Chapters 1 in Rishbeth & Garriott and 4.1 in Hargreaves).

UNIT – II: Ionized Atmosphere:
Photochemical processes in the ionosphere, Continuity equation and photochemical equilibrium, Theory of Photo-ionization and Chapman production function, Chemical recombination and electron density, Solar radiation and production of ionospheric layers, Loss reactions, Different types of recombination processes. Linear and square law loss formulae and splitting of ionospheric F layer.
(Chapters 3, 5 and 6 in Rishbeth & Garriott and 4.2, 4.3 and 10 in Hargreaves).

UNIT – III: Ionospheric Radio Wave Propagation:
Theory of wave propagation - Properties of plane waves in isotropic and anisotropic media. Group propagation, Ray and group velocities, Phase and group paths. *(Ch. 2.5 – 2.10 in Davies).*
Radio waves in ionized media - Propagation in isotropic plasma and refractive index, Concepts of critical frequency and virtual height, Magnetoionic theory – constitutive relations of magneto plasma and the Appleton-Hartree (A-H) formula for refractive index, Ordinary and extraordinary waves.
(Ch.4 in Davies).

UNIT – IV: Ionospheric Sounding Techniques:
Ground based techniques - Pulse sounding and ionosonde, Reduction of ionograms to N-h profiles, Ionospheric absorption – Deviative and Non Deviative, Absorption measurement by A1 and A2 techniques, Faraday rotation and Total Electron Content (TEC), Scattering of radio waves in the ionosphere – incoherent scatter radar and coherent scatter (MST) radar.
(Ch.2 in Rishbeth & Garriott and Appendix A in Kelly & Heelis).

UNIT – V: Ionospheric Sounding Techniques:
Rocket & Satellite techniques - Satellite drag experiment for atmospheric density, Langmuir Probe (LP) and Retardation Potential Analyzer (RPA), Ion mass spectrometers, Fluxgate magnetometer, Double probe electric field detectors, Barium ion cloud measurements.
(Chs.1&2 in Rishbeth & Garriott & Appendix A in Kelly&Heelis).

Text Books:

1. Introduction to ionospheric physics - H. Rishbeth & O. K. Garriott
2. Upper Atmosphere and Solar Terrestrial Relations - J. K. Hargreaves
3. Ionospheric radio propagation - K. Davies
4. The earth's ionosphere (Plasma physics & dynamics) - M. C. Kelly & R. A. Heelis

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P 405 & P 406: PROJECT WORK DISSERTATION & PROJECT WORK VIVA

(Effective from 2021-22 Admitted Batches)

The project helps the student to experience science in action. The student gets to know how the knowledge he/she has gained can be put to use to solve real time problems.

The student gains insight into various steps involved in science research - literature survey, getting to know different methods of solving the problem on hand, deciding the right approach and eventually solving the problem assigned.

Course Objective:

The aim of the project is to provide glimpses of latest research going on in various areas of Physical Sciences.

Learning Outcome:

The completion of the successful project will prepare the students for higher level research in different thrust areas of Physical Sciences.

This project based learning will facilitate a career in various institutions such as research and development centers of private and public organizations, educational institutions like Universities, Colleges, Schools, etc. and also emerge as enterprenuers.

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M.Sc. Physics Programme

Matrix Mapping of PO's vs CO's

(FOURTH SEMSTER)

P 401: ADVANCED QUANTUM MECHANICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2	✓	✓		✓	
PO-3					
PO-4					
PO-5					

P 402: PROPERTIES & CHARACTERIZATION OF MATERIALS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓	✓			
PO-2			✓		
PO-3					
PO-4					
PO-5					

P 403: ELECTIVE PAPER: 1. NANO MATERIALS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2	✓	✓	✓		
PO-3					
PO-4				✓	
PO-5					

P 403: ELECTIVE PAPER: 2. ANTENNAS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1	✓				
PO-2		✓	✓		
PO-3					✓
PO-4					
PO-5					

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P 404: ELECTIVE PAPER: 1. COMMUNICATION ELECTRONICS

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2				✓	
PO-3	✓	✓			
PO-4					
PO-5					

P 404: ELECTIVE PAPER:

2. IONOSPHERIC RADIO WAVE PROPAGATION & SOUNDING TECHNIQUES

	CO-1	CO-2	CO-3	CO-4	CO-5
PO-1			✓		
PO-2		✓			
PO-3	✓			✓	
PO-4					
PO-5					

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