SYLLABUS FOR M. Sc. COURSE IN PHYSICS

KHALLIKOTE UNITARY UNIVERSITY

BRAHMAPUR-760 001

Website:kuu.ac.in

With effect from 2025-27

Annexure-'A'

Common Academic Calendar: 2023-24 (Universities)		
SL No.	**Activity**	**Timeline**
1	Reopening of the HEIs after the Summer Vacation for the Academic Session: 2022-23	21.06.2023
	Admission Process:	
2	i) for UG 1st year	19.06.2023 to 07.10.2023
	ii) for PG 1st year	01.05.2023 to 13.10.2023
	Commencement of Classes:	
3	i) UG 3rd year	21.06.2023
	ii) UG 2nd year	21.06.2023
	iii) UG 1st year	21.08.2023
	iv) PG 2nd year	21.06.2023
	v) PG 1st year	21.08.2023
4	Celebration of International literacy Day	8th Sept 2023
5	Celebration of Gandhi Jayanti	2nd Oct 2023
6	Puja Vacation	21.10.2023 to 28.10.2023
7	Celebration of National Education Day	11th Nov 2023
8	**Mid Semester Examination (Both UG & PG):**	
	i) Odd Semester (1st/3rd/5th)	Last week of October-2023
	ii) Even Semester (2nd/4th/6th)	Last week of February-2024
	End Semester Examination (Both UG & PG):	
	i) Odd Semester (1st/3rd/5th)	3rd week of December-2023
	ii) Even Semester (2nd/4th/6th)	By 2nd week of May-2024
9	X-Mass Holiday	25th December 2023
10	Annual Sports/ Cultural week to conduct all the competitions and event	01.11.2023 to 10.11.2023
10(a)	State level Inter University Games	01.12.2023 to 12.12.2023
11	Filling up of forms for University Exam	UG/PG: As notified by concern University
12	Alumni Meet	last week of January-2024
13	Celebration of National Science day	28th February 2024
14	**Publication of Result:** UG/PG- 1st/2nd/3rd/4th/5th/6th Sem Exam	Within 45 days from last theory examination of concern Semester exam. Subject to publication of last semester exam. in the last week of June-2024
15	Weekly Academic Seminar	U.G. : Every Monday of the Week
		P.G.: Every Tuesday of the Week
16	Total No. of Holidays	72 days, excluding Sundays
17	Total No. of Reserve Holidays	Maximum 02 days
	Total No. of Teaching Days	Minimum 180 days
18	Summer Vacation	5th May 2024 to 19th June 2024(tentatively)

12.09.2023

SYLLABUS FOR MSc COURSE IN PHYSICS

SL NO	SEMESTER	PAPER	SUBJECT	CREDITS	FULLMARKS 100	
					MID TERM	END TERM
1	I	101	Classical Mechanics	4	20	80
2		102	Electrodynamics-I	4	20	80
3		103	Quantum Mechanics-I	4	20	80
4		104	Solid State Physics	4	20	80
5		105	PRACTICAL (Computational Physics)	6	20	80
6		106	Indian Knowledge System	0		
6	II	201	Mathematical Methods of Physics	4	20	80
7		202	Electrodynamics-II and Plasma Physics	4	20	80
8		203	Quantum Mechanics-II	4	20	80
9		204	Atomic and molecular Physics	4	20	80
10		205	PRACTICAL(Optics,Electricity &Magnetism & Electronics)	6	20	80
11	III	301	Electronics- I	4	20	80
12		302	Nuclear Physics-I	4	20	80
13		303	Relativistic Quantum Mechanics	4	20	80
14		304	Statistical Mechanics	4	20	80
15		305	PRACTICAL (electronics)	6	20	80
16	IV	401	Electronics-II	4	20	80
17		402	Nuclear Physics-II & Particle Physics	4	20	80
18		403	Quantum Field theory	4	20	80
19		404	PROJECT PAPER	4	20	80
20		405	Practical (Electronics)	6	20	80
	Total			88	400	1600

FIRST SEMESTER

P – 201 Classical Mechanics

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit - I Kinematics of Rigid Body Motion

Rigid body motion, The independent coordinates of a rigid body, orthogonal transformation. Eulerian angles. Infinitesimal rotation, Rate of change of vector, the Coriolis force. Angular momentum and kinetic energy of motion about a point. The inertia tensor and the angular momentum of a rigid body. The heavy symmetrical top with one point fixed.

Unit - II Variational Principle

Legendre transformation and the Hamilton's equation of motion from a variational principle, conservation theorem and the physical significance of Hamiltonian. The principle of least action.

Unit - III Canonical Transformations

The equation of canonical transformation. Example of canonical transformation. The integral invariant of Poincare. Lagrange and Poission Bracket as canonical invariant, the equation of motion in Poission Bracket's notation, the infinitesimal contact transformations.

Unit – IV Small Oscillations

The Hamilton Jacobi equation for Hamilton's principal function. The harmonic oscillator problem as an example of H.J. Method, Kepler problem.

Small oscillations, formulations of the problem, the eigenvalue equation and the principal axis transformations, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.

Test Books:

1. Classical Mechanics- by H. Goldstein (Addison-Wesley)

Reference books:

1. Classical Mechanics by S. N. Biswas, Books and Allied Publisher Ltd.
2. Classical Mechanics by J.C. Upadhyay, Himalaya Publishing House.
3. Classical Mechanics by Landau and Liftshitz (Butter Worth)

Course Outcomes:

- Understand the basic mechanical concepts related to discrete and continuous mechanical systems.
- Describe and understand motion of a rigid body and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
- Understand the canonical transformation and small oscillations.

P – 102

Electrodynamics-I

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks 100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit-I Inhomogeneous wave equation

The wave equations for the potentials, Solution by Fourier analysis, The radiation fields, radiation energy, Radiation from monochromatic source center-fed linear antenna.

Unit-II Wave Guides

Electric and magnetic field due to an oscillating dipole, Power radiated by a dipole, Wave guides and resonant cavities: Cylindrical cavities and waveguides, Mode in a rectangular wave guide, resonant cavities.

Unit-III Radiation-I

Radiation by a moving charge: The L.W. potentials, the fields due to a charge in uniform motion, Direct solution of the wave equation, Radiation from an accelerated charge: Fields of an accelerated charge, Radiation at low velocity.

Unit-IV Radiation-II

Total power radiated by an accelerated charge, Larmor's formula, Angular distribution of radiation power from an accelerated charge, The cases of acceleration parallel to velocity, The case of acceleration perpendicular to velocity.

Text Book:

1.'Introduction to Electrodynamics", Griffiths D J, Prentice Hall.
2. Classical Electrodynamics", Jackson J D, John Wiley.

Reference books:

1. "Classical Electricity and Magnetism" by Wolfgang K.H.Panofsky and Melba Philips , Second Edition
2. Modern Electrodynamic by Zangwill.

Course Outcomes:

- Discuss the inhomogeneous wave equation and find out its solution by Fourier analysis.
- Discuss radiation by a moving charge Lienard- Wiechart potential and field of a uniformly moving electron.
- Derive the total power radiated by an accelerated charge.
- Calculate different modes of electromagnetic waves in waveguides
- Show that accelerating charge produce electromagnetic radiation

P – 103 QUANTUM MECHANICS - I

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I General Principles of Quantum Mechanics.

Linear vector space, ket and Bra vectors, scalar product of vectors. The Kronecker and Dirac delta function. Linear Operators, Adjoint, Unitary Operators, Expectation values of dynamical variables and physical interpretation, Hermitian

Operators. Eigen Values and Eigen vector, Orthonormality of Eigen vectors, Probability interpretation, Degeneracy, Schmidt method of Orthogonalization. Representation of Ket and bra vectors and operators in matrix form, Unitary transformations of basis vector and operators.

Unit – II Quantum dynamics

Schrödinger's Equation of time, evolution of quantum states, Schrödinger picture, Heisenberg picture, Interaction picture, Equation of motion. Operator formalism, Postulates of quantum mechanics, operator method solution of Harmonic oscillator, Matrix representation and time evolution of creation. annihilation operators.

Unit – III Orbital Angular Momentum

Orbital angular momentum operators L_x, L_y, L_z and L^2 and their commutation relations, L_x, L_y, L_z and L^2 in Spherical Polar Coordinate. Eigen value of L^2 and L_z with respect to Spherical harmonics, Raising and Lowering operators, Orbital angular momentum wave function, Matrix representation of L^2, L_x,L_y, L_z, L_+ and L, Angular momentum on generators of rotation.

Unit – IV Spin - angular momentum

Spin 1/2 Particles, Pauli-spin matrices and their properties, Eigen values and Eigen functions, Spinor transformations under rotation.Addition of angular momenta.Total angular momentum$J$. Eigen value problem of J_z & J^2, Angular momentum matrices,Addition of angular momenta, Clebsch Gordon Coefficients and their values for $J_1 = 1/2$, $J_2 = ½$ and $J_1=1$ and $J_2= 1/2$.

Textbooks:

1. " Quantum Mechanics: Concepts and Applications" by NouredineZettile John Wileyandsons.

Reference Books:

1. "Quantum Mechanics", L.I. Schiff L.I 3rd Ed, McGraw Hill Book Co.
2. "Quantum Mechanics'. Merzbacher, 2nd Ed., John Wiley &Sons.
3. , "Quantum Physics", S.Gasiorowicz John Wiley.
4. "A Text Book of Quantum Mechanics" by P.M. Mathews. and Venkatesan, Tata McGraw Hill.
5. Introduction to Quantum Mechanics, by D.J. Griffiths ,2nd edition, Pearson Publications

Course Outcomes:

- State and explain the basic postulates of quantum mechanics.
- Solve Schrodinger equation of harmonic oscillator problem completely using operator method
- State addition of angular momentum theorems and spin angular momentum statistics

P – 104 SOLID STATE PHYSICS

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Band Theory

Bloch's theorem, wave equation of an electron in a periodic potential, Kronig Penney model, Origin of band gap, Nearly free electron model, Brillouin zones for square and cubic lattices, zone schemes, Classification of solids (Conductors, Semiconductors and Insulators).

Unit - II Energy Bands calculations

General properties of Energy bands, Properties of Bloch functions, Tight Binding methods, Orthogonalized plane waves, Pseudopotential methods of energy band calculations, de-Haas-van Alphen effect.

Unit – III Semiconductor

Representation Theory and Wannier functions, equation of motion in Wannier representation, Equivalent Hamiltonian and impurity levels, Intrinsic and extrinsic semiconductor, Laws of mass action and Hall effect, Intrinsic carrier concentration, Mobility in the intrinsic region.

Unit-IV Imperfections in crystals & Solid-State Devices

Classification, Schottky defects, Frenkel defects, Extrinsic vacancies, diffusion through solids, colour centers, Tunnel diode, Solar cells, photo voltaic detectors and cells, Schottky barriers, gun effect oscillators, photo diode, photo resistors, Infrared and ultraviolet detector, Avalanche photodiode, phototransistor.

Text Book:

1. Aschroft and Mermin (2021) Solid State Physics,John wiley and sons, USA.
2. Ghatak and Thyagarajan (2019) LASERS: Fundamentals and Applications, McMillan India.
3. Kittel C (2019) Introduction to Solid State Physics, John wiley and sons, USA.
4. Pillai SO (2022) Solid State Physics, New Age Publication, New Delhi.

Reference Book:

5. Puri RK & Babbar VK (2010) Solid State Physics- S.Chand Publication, Merrut.
6. Shur Michael (1990) Physics of Semiconductor Devices,PHI, USA.
7. Wahab MA (2015) Solid State Physics, Narosa Publications, Mumbai

Course Outcome

1. Discuss the Bloch’s theorem, kronig penny model and the origin of the energy band gap.
2. Calculated the energy bands, tight binding .
3. Discuss the intrinsic and extrinsic semiconductor, representation theory and wannier functions.
4. Discuss the imperfections in crystals and solid state devices.

PAPER-105 (PRACTICAL)

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

Student must secure minimum 50% in practical paper to be declared as pass

Programming in FORTAN: Introduction to FORTRAN, Structure of a FORTRAN program, Input and output statements, Control statements, Arrays, Sub programs, Data Files, examples of writing FORTRAN programming of computational methods.

Numerical Techniques:
Interpolation, solution of algebraic equation, least-square curve fitting, linear algebra and matrix manipulations, inversion, eigenvectors and eigen values, numerical differentiation, numerical integration, Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods, random number generation.

Text Books

1. V. Rajaraman, Fundamentals of Computers (Prentice Hall, India).
2. C. Xavier, Fortran 77 and Numerical methods.
3. V. Rajaraman, Computer Programming in FORTRAN 90 and 95

Course Outcome

1. Write computer programs using FORTRAN 90
2. Use different numerical methods to solve problems using computer programs.

PAPER-106 (Indian knowledge System)

UNIT-I Introduction to Indian Knowledge System
What is knowledge? Subject, object and sources of knowledge, Four Vedas, Indian philosophical systems, Vedic and non-Vedic schools, Nyaya theory of knowledge, Nitti sastra, and the four purusharthas(goals of life).

UNIT-II Vedic Knowledge, Philosophy and technology with practices
Traditional agriculture practices, traditional ayurveda and plant-based medicines, 64 art forms and occupational skills (64 Kalas), metals and metal working technology, town and planning architecture in India, Vastu sastra, A vaisesikan approach to physical reality, constituents of physical reality.

UNIT-III Vedic Physics and Philosophy
Study of the philosophical and metaphysical foundations of Indian physics, concepts like Prakriti (nature), Purusha (consciousness), and their relevance to physics, Vedic cosmology and its connection to modern cosmological theories.

UNT-IV Classical Indian Physics
Detailed exploration of classical Indian physics principles, theory of five elements (Panchabhuta) and the concepts of ether (Akasha), concepts like sound (Nada), light (Prakasha) and heat (Tejas) in Indian Physics.

Textbook:

1. "Indian Philosophy: A very short Introduction" by Sue Hamilton
2. "A history of Indian Philosophy" by Surendranath Dasgupta
3. "Indian Physics: Outline of Early History" by David Pingree
4. "The wisdom of Vedas" by Jyotir Maya Nanda
5. R.S. Kausal, D.K. Printworld (P) Ltd. (Publishers of Indian Traditions)

Course Outcome

1. Students will be able to gain insights into the concept of traditional knowledge and its relevance.
2. They will also be able to understand and connect up the basics of Indian traditional knowledge with modern perspective.

SECOND SEMESTER

P-201 Mathematical Methods of Physics

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks 100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit - I Complex variables and Delta function

Multivalued function. Branch point & branch cut, simple conformal mapping and applications, Schwartz-Christoffel transformation, Dirac delta function and its properties.

Unit - II Special Functions

Hypergeometric and confluent Hypergeometric equation by generating function method and their properties. Solutions of inhomogeneous partial differential equations by Green's function method.

Unit - III Tensors

Covariant, contravariant and mixed tensors rank of a tensor, symmetric and Antisymmetric tensors, invariant tensor, epsilon tensor, pseudo tensors, properties of tensor, metric tensor, raising and lowering of tensors, covariant derivative, Christoffel symbols.

Unit - IV Group Theory

Definition, subgroups and classes, Cayley's theorem, group representation characters. Reducible and irreducible representation of SU (2) and O (3) group.

Textbooks:

1. Mathematical Methods of Physics by Mathews and Walker (W. A. Benjamin Inc.)
2. Matrices and Tensors in Physics by A. W. Joshi (New Age International Publisher)
3. Mathematical Methods in the Physical Science by Mary L. Boas (Wiley- India)
4. Mathematical Methods for Physics – Arfken and Weber;

Reference Books:

4. Elements of Group Theory by A. W. Joshi
5. Mathematical Physics by H. K. Das and Dr R. Verma

Course Outcomes:

- Demonstrate the utility and limitations of a variety of powerful calculation techniques and to provide a deeper understanding of the mathematics and its useful in theoretical physics.
- Students will be able to apply these to solve problems in classical, statistical and quantum mechanics, electromagnetism as well as solid state physics.

PAPER-202 Electrodynamics and Plasma Physics-II

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

4. There will be two groups in each question paper.
5. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
6. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit-I Radiation, Scattering & Dispersion

Radiative damping of a charged harmonic oscillator, forced vibrations, Scattering by an individual free electron (Thomson scattering) and by a bound electron (Rayleigh scattering), Dispersion in gases (Lorentz-theory) Normal and Anomalous dispersion, causality and dispersion relation.

Unit-II Diffraction and Covariant Formulation

Kramer - Kronig relation, Kirchoff's formulation of diffraction, diffraction by a circular aperture, Four vector notation, Relativistic particle kinematics and dynamics.

Unit-III Covariant form of Maxwell's equation

Maxwell's equation in four vector form, Maxwell field tensor, Covariant definition of electromagnetic energy and momentum, Transformation of electromagnetic field components, Lagrangian of a charged particle in an external electromagnetic field.

Unit-IV Plasma

Introduction, Conditions for plasma existence, Occurrence of plasma, Charged particle in electric & magnetic fields: Charged particle in uniform constant electric field, Charged particle in homogeneous magnetic field, Charged particle in simultaneous magnetic field and electric field, Charged particle in uniform constant electric filed Charged particle in homogeneous magnetic field, Charged Particle in simultaneous magnetic field and electric field, Charged particle in non homogeneous magnetic field, Magneto hydrodynamics, Magnetic confinement-Pinch effect. Instabilities in pinched plasma column, Plasma waves

Text Book:

1.'Introduction to Electrodynamics", Griffiths D J, Prentice Hall.
2. “Classical Electrodynamics", Jackson J D, John Wiley.
3. “Basic Plasma physics” by Basudev Ghosh.
4. “Fundamentals of plasma physics” by J.A Bittencourt

Reference books:

3. "Classical Electricity and Magnetism" by Wolfgang K.H.Panofsky and Melba Philips , Second Edition
4. Modern Electrodynamic by Zangwill.
5. Electricity and Magnetism by Fewkeys JH & Yarwood

Course Outcomes:

1. Discuss the radiation, Scattering and Dispersion in details.
2. Derive the Kramer- kronig relation, kirchoff’s formulations of diffraction, diffraction by a circular aperture.
3. Demonstrate and analyse Maxwell’s wave equation and derive Maxwell’s equation in covariant form.

4. Discuss the condition of plasma existence and occurrence of the plasma
5. Discuss the charged particle in uniform constant electric filed, magnetic field and the magneto hydrodynamics.

P-203 QUANTUM MECHANICS - II

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Central Forces

Hydrogen atom, Parity, Reduction to equivalent one body problem, Radial equation, Energy Eigen values and Eigen functions. Degeneracy, Radial probability distribution, The free particle problem, Expression of plane waves interims of spherical waves, Bound states of 3D square well, Particle in a sphere.

Unit – II Approximation methods

Time independent perturbation theory (Non degenerate and degenerate), Removal of degeneracy, Linear and quadratic Stark effect. Normal and anomalous Zeeman effect, Fine structure of spectral lines of H-Like atoms.

Unit - III Variational method

Ground state of the He-atom WKB method, Connection formulae, Bohr-Sommerfeld quantization rule, Time dependent perturbation theory, Fermi golden rule, Harmonic perturbation and constant perturbation, Einstein A and B coefficients.

Unit – IV Scattering

Scattering amplitude and cross section, Born approximation, Application to coulomb and screened coulomb potentials.

Partial wave analysis for elastic and inelastic scattering, optical theorem, Scattering from a hard sphere.

Home Assignment

Text Books

1. Quantum Physics - S. Gasiorowicz.
2. Quantum Mechanics- N. Zettili
3. Quantum Mechanics- B.H. Bransden, C.J. Joachain
4. Quantum Mechanics - R. Shankar
5. Quantum Mechanics - A. K. Ghatak and S. Lokanathan

Reference Books :

1. Quantum Mechanics- E. Merzbacher
2. Quantum Mechanics - S. N. Biswas
3. Quantum Mechanics - L.I. Schiff
4. Quantum Mechanics vol I - A.Messiah
5. Principles of Quantum Mechanics - P. A. M. Dirac
6. Quantum Mechanics (Non-relativistic theory) - Landau and Lifshitz
7. Modern Quantum Mechanics - J. J. Sakurai
8. Advanced Quantum Mechanics – P. Roman

Course Outcomes:

- Derive energy and wave function for physical system using time independent perturbation theory
- Explain Stark effect, and fine structure of hydrogen atom and Zeeman effect
- Solve the scattering Marks: 100 amplitude and cross section, scattering from a hard sphere.
- Apply variational principle to find out the ground state energy of the various physical sys

P-204 ATOMIC AND MOLECULAR PHYSICS

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

4. There will be two groups in each question paper.
5. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
6. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit–I Review of one electron and Many electrons atoms

Schrodinger equation, Para and Ortho states, Pauli-Exclusion Principle, Excited states, doubly excited states, Auger effect, resonance, Many electron atoms: Central field approximation, Thomas-Fermi model, Hartree - Fock method and self-consistent field, Hund's rule, L-S and j-coupling.

Unit – II Interaction with Electromagnetic fields & Molecular structure

Selection rules, spectra of alkalis, Helium and alkaline earths, multiplet structure, Zeeman and Stark effect, Molecular structure: General nature, Born-Oppenheimer separation, rotation and vibration of diatomic molecules. Electronic structure of diatomic molecules, structure of polyatomic molecules.

Unit–III Molecular spectra

Rotational vibrational Spectra, Electronic spectra of diatomic molecules, electronic spin and Hund's cases and nuclear spin, Raman and Infra-Red spectrums.

Unit–IV Atomic collisions & Resonance Spectroscopy

Atomic collisions: Types of collisions, channels, Threshold, cross-sections, Potential scattering, general features, Born approximation, Resonance Spectroscopy: NMR, NQR, ESR and Mossbauer spectroscopies

Home Assignment

Text Book:

1. Atomic and Molecular Spectra: Laser by Raj Kumar
2. Physics of Atoms and Molecules by Bransden & Joschain.

Reference Book

1. Introduction to atomic spectra by H. E. White

Course Outcome

1. To Understand the one electron and many electron atoms.
2. To understand the spectra of alkalis, zeeman and stark effect.
3. Discuss the Atomic collision and resonance spectroscopy.

P – 205 PRACTICAL

Marks:100 Duration: 3 hrs.

Optics, Electricity, Magnetism and Electronics

1. Anderson's Bridge
2. Heaviside Bridge
3. Maxwell's Bridge
4. Carey-Foster Bridge
5. Rayleigh’s Bridge 7. Owen's Bridge
6. Dielectric Constant of a liquid by electrically maintained tuning fork.
7. B-H Curve, Oscilloscopic display
8. Characteristics of vacuum tubes and transistors.
    a. Diode, Triode and Pentode
9. Setting up an oscillator (A.F. & R.F.)
10. Setting up of an amplifier and study of its characteristics.
11. Setting of power supply
12. L C R Bridge
13. Michelson Interferometer 16. Fabry parot Interferometer.
14. Babinet’s Compensator

THIRD SEMESTER

PAPER-301 Electronics - I

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit-I Feedback amplifiers
series current and voltage feedback amplifier, Oscillators: Negative resistance oscillators - dynatron tunnel – diodes.

Unit-II Modulation

Amplitude modulation, frequency modulation and phase modulation, Collector modulated class amplifier, outline of AM and FM transmitters, Demodulation: diode detectors, FM detection Discriminator-ratio detectors, A/D and D/A Convertors-Basic idea of digital modulation.

Unit–III Microwaves
Principle of velocity modulation theory and operation of Klystron, Magnetron, Characteristics of microwave diodes and cavity resonator, AFC (Automatic Frequency Control) of microwaves

Unit–IV Antenna theory & Quantum Electronics
Radiations from doublet antenna, Radiation field of a dipole vertical wire antenna, image antennas, Directivity of antenna array, Yogi and Rhombic antenna, Radiation resistance and Power impedance matching, Fibre optics- Principles of optical communication, Basic Principle of Maser action, spontaneous and stimulated emission-important Maser devices Maser devices optical masers (Lasers) Laser oscillation condition and population inversion - Oscillation frequency.

Text Books:

1. Electronic Fundamentals and Applications by J.D Ryder.
2. Hand book of Electronics by Gupta and Kumar

Reference Books
1. Digital Principles and Applications by Malvino

Course Outcome
1. To understand the feedback amplifiers.
2. To understand the amplitude, frequency and phase modulation.
3. To understand the principle of velocity modulation theory and operation of Klystron and Magnetron.
4. Discuss the Antenna theory and Quantum electronics.

PAPER – 302 NUCLEAR PHYSICS - I

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit - I Nuclear properties & deuteron

Introduction: Brief discussion of nuclear properties, the two body nuclear problem, the deuteron (ground and excited state), tensor forces, magnetic and quadrupole moments of deuteron, Exchange property of nuclear force.

Unit - II Neutron **proton scattering**

Neutron proton scattering at low energies, scattering cross-section, scattering length, spin dependence of neutron-proton scattering. Effective range theory.

Unit – III Nuclear Models

Semi empirical mass formula. Nuclear models, extreme single particle model, magic numbers, shell model, predictions of spin, parities, magnetic moments of nuclei Elementary ideas of rotational and vibrational levels.

Unit - IV Nuclear Disintegration Studies

Nuclear fusion, Nuclear fission: Elementary ideas of fission and liquid drop model (Bohr and Wheeler theory), Nuclear disintegration studies: Alpha decay, Gamow's theory of Beta decay, Geiger - Nuttal law, Gamma ray energies and fine structure of Gamma rays

Test Book:

1. Nuclear Physics by Roy Nigam.

Reference Books:

1. Theoretical Nuclear Physics by Blatt JM & Weisskopf VF
2. Physics of Atoms and Molecules by Bransden.

Couse Outcome

1. Discuss two body nuclear problem, the deuteron and tensor forces.
2. Discuss nuclear models.
3. Discuss Nuclear Fusion, Nuclear fission, Alpha decay.
4. Discuss Geiger - Nuttal law, Gamma ray energies and fine structure of Gamma rays.

P -303 RELATIVISTIC QUANTUM MECHANICS

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit - I Relativistic Quantum Mechanics -I

Klein – Gordon equation, continuity equation and probability density, K.G. particles in an e. m. field, Dirac equation and properties of Dirac matrices, Solutions of Dirac equation for a free particle, states with positive and negative energy, Dirac's hole theory, Bispinor plane-wave amplitudes u and v, Spin states, Helicity, projection operators for energy and spin.

Unit - II Relativistic Quantum Mechanics -II

Non-relativistic correspondence, Gordon's decomposition, Existence of spin for electron, total angular momentum, zitter bewiing, Spin-orbit coupling energy, Covariant form of K.G. equation and Dirac equation, Algebra of Dirac gamma matrices.

Unit - III Dirac Equation

Dirac equation for a particle in external spherically symmetric field, Stationary states, Separation of angular and radial variables, Solution of radial equation in the case of Coulomb potential, Energy Spectrum of hydrogen-like atom, Degree of degeneracy and fine structure of energy levels.

Unit - IV Equivalence

Equivalence of representations, Standard representation, Trace identities, Invariance of Dirac equation under proper Lorentz transformations, Space inversion, time inversion, charge conjunction, bilinear covariant.
Internal Assessment

Test Book

1. Relativistic quantum Mechanics by Jorken and Drell
2. Advanced Quantum Mechanics – J.J. Sakurai.

Reference Book

1. Quantum Field theory by Ryder.
2. Quantum Field theory by Mandel and Shaw.

Course Outcome

1. Explain the relativistic quantum mechanical equations, namely, Klein-Gordon equation and Dirac equation.
2. Describe second quantization and related concepts

P-304 STATISTICAL MECHANICS

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Classical Statistical Mechanics

Postulates of classical statistical mechanics, Liouville's theorem, Microcanonical ensemble, Derivation of thermodynamics, Equipartition theorem, classical ideal gas, Gibb's paradox. Canonical ensemble and energy fluctuation, Grand canonical ensemble and density fluctuation, Equivalence of canonical and grand canonical ensemble.

Unit–II Quantum Statistical Mechanics

Postulates of Quantum statistical mechanics, The density matrix, Ensembles in quantum statistical mechanics. Third law of thermodynamics, Ideal gas in micro canonical, canonical and Grand canonical ensemble.

Unit – III Ideal Fermi & Bose Gas

Equation of state of an Ideal Fermi gas, Theory of white dwarf stars, Landau diamagnetism, Pauli Para magnetism. Ideal Bose gas, Photons and Plank's law, phonons and Debye's theory of specific heat, Bose-Einstein condensation, liquid He.

Unit - IV Phase Transitions:

Landau theory of phase transition, Theory of YANG and Lee, condensation of Vander Waals gas, The Ising Model: Definition of the Ising model, One-dimensional Ising model.

Internal Assessment

Text Book:

1. Statistical Mechanics- R. K. Patheria, P.D. Beale 3rd Ed, Butter Worth-Heinemann
2. Statistical Mechanics – K. Huang, Wiley India

Course Outcome

1. State postulates of classical and quantum statistical mechanics
2. Differentiate between microstate and macrostate
3. Tell the significance Gibb’s paradox and indistinguishability in statistical mechanics.
4. Describe thermodynamics of phase transition and formulate the Ising model of phase transitions for ferromagnetism.

P – 305 PRACTICAL (Electronics-1)

PRACTICAL (Electronics)

Marks: 100 Duration: 6 hrs.

1. Study of two stage RC amplifier with frequency compensator.
2. Study of two stage tuned r. f. amplifier.
3. Study of negative feedback amplifier.
4. Study of square wave response of a video amplifier.
5. Study of VTVM
6. Study of Q meter
7. Colpitt's Oscillator
8. An Hartley Oscillator
9. Study of gates.
10. Zener diode.

FOURTH SEMESTER

P – 401 Electronics -II

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Theory of Lasers and Laser Systems

Einstein's prediction and relations, conditions for stimulated emission and light amplifications. Line shape function, population inversion, metastable states, Pumping schemes amplification and gain. Critical population inversion, Conditions for steady state Oscillation, cavity resonance line broadening, Gain saturation and gain band width modes, properties of laser modes, laser rate equation.

Unit - II Applications of laser

Types of Lasers - Solid state & gas lasers, Dye laser semiconductor laser, Free electron laser.

Unit -III Bipolar Transistors and JFET

The Bipolar transistor action, minority carrier distribution, transistor currents and low frequency common base current gain, non ideal effects, equivalent circuit models, frequency limitations, large signal switching.

JFET concepts: basic pn JFET operation, basic MESFET operation, the device charactersitics, non ideal effects, equivalent circuits and frequency limitations.

UNIT-IV MOSFET

The two terminal MOS structure- energy band diagram, depletion layer thickness surface charge density, work function differences, flat band voltages, threshold voltages, capacitance voltage characterstics, the basic MOSFET operation, frequency limitations, the CMOS technology, non ideal effects, MODFET scaling, threshold voltages modifications.

Home Assignment

Text Books:

1. Solid state electronics devices 7th edition by Ben G streetman and Sanjay banarjee
2. Semiconductor physics and Devices 4th edition by Donald A Neamen and Dhrubes Biswas
3. Fibre Optics and Optoelectronics by R.P. Khare
4. Microwave Principle by Reich
5. An introduction to Laser theory and applications by M.N. Avadhanulu

Reference Book:

Laser Fundamentals by William, S.Chand & Co. selfvast.
Optical Electronics by Yariv

Course Outcome

1. To understand the theory of laser and laser systems.
2. To under the function of BJET and JFET along with MOSFET.

P – 402 NUCLEAR PHYSICS & PARTICLE PHYSICS

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Decay Theory

Beta decay, Fermi's theory of Beta decay, Curie plot and Beta - ray spectrum, Parity violation of - decay, allowed and forbidden transitions, selection rules, Gamma transition, interaction of gamma rays with matter, Pair production, internal conversions.

Unit - II Nuclear reaction & Mechanism Nuclear reaction, reaction energetics, Q-value equation. Direct compound nuclear reaction.

Mechanism: Cross sections in terms of partial wave, amplitudes. Compound nucleus - Scattering matrix, Reciprocity theorem - Breit Wigner one level formula Resonance Scattering.

Unit - III Particle Physics-I

Classification of elementary particles and different types of interaction, Conservation laws, Baryon Number, Lepton number, Gellmann Nishijma scheme, Isospin and Isospin quantum numbers, Hypercharge, strangeness.

Unit - IV Particle Physics-II

Invariance principles and symmetries, conservation of parity, charge conjugation symmetry, time reversal, CPT theorem and its consequence, elementary ideas about quark model, Color quantum number, SU(3) symmetry, Baryon and Meson octet.

Home Assignment (Seminar)

Text Books

1. Nuclear Physics - Roy and Nigam
2. “Introduction to high energy Physics” by Donald H Perkins.
3. “Introduction to elementary particles physics” by Griffth

Course Outcome

1. To understand the different types of the Decay processes.
2. To understand the nuclear reaction and its mechanism.
3. To understand the basics of particle physics along with different principles and symmetries.

P -403 QUANTUM FIELD THEORY

Marks: 100 Duration: 3 hrs.

20 Mid Term+80 End Term = Full Marks100
Pattern of questions in Term End Examination

1. There will be two groups in each question paper.
2. Group - A carries 10 short questions each carrying 2marks, So 2X10 = 20 Marks.
3. Group - B Questions No.2 to No.5. Total four questions and one long question with an alternative to be attempted. Each question carries 15 marks, So 4X15 = 60 Marks.

Student must secure minimum 40% in theory paper and 50% in practical paper to be declared as pass.

Unit – I Relativistic classical field I

Variation principle and Euler – Lagrange equations, Definition of field, Second quantization, Symmetric and conservation laws, Noether's theorem, energy-momentum tensor, angular momentum.

Unit - II Relativistic classical field II

Lagrangian density for Klein – Gordon, Dirac and Maxwell fields, Internal symmetry, Invariance under phase transformations and conservation of vector current (charge), Local gauge transformations.

Unit - III Quantization of free fields and particle interpretation

Real and Complex K – G field, Canonical quantization and commutation relations for creation and annihilation operators, Energy, momentum and charge of the quantized field, Dirac field, positivity of energy and anticommutation relations, Bosons and Fermions, antiparticles, Relativistic covariance of canonical quantization.

Unit - IV Interaction of quantized fields

Unequal space-time commutation and anticommutation relations, Properties of delta function and its integral representations, vacuum expectation value, normal order, Time-ordered product, Dyson's chronological product and Wick's chronological product, S-matrix, Wick's theorem, Feynman diagram and Rules

Home Assignment

Text Book

1. Quantum Field Theory by Itzykson and Zuber
2. Quantum Field Theory by L. H. Ryder
3. Quantum Field Theory by Schweber
4. Quantum Field Theory by Mandel and Shaw

Course Outcome

1. Discuss the relativistic classical field and its gauge transformation.
2. Discuss the quantization of free fields.
3. Discuss the Unequal space-time commutation and anticommutation relations.
4. Discuss the Wick's theorem, Feynman diagram and Rules

P – 404 PROJECT

Marks: 100

Topics include: Nano Science and Nano Technology, Materials Science, Nuclear Matter, Black Hole Physics, Accelerators Physics, Biophysics, Superconductor, Energy Band Calculations, General Theory of Relativity, Cosmology, Astro particle Physics, High Energy Physics,

Dissertation: 50 marks, Presentation and Viva: 50 marks

P-405
PRACTICAL Electronics II

Marks:100 Duration: 6 hrs.

1. Study of two stage RC amplifier with frequency compensator.

Experiment with Transistor:

1. F E T Characteristics
2. Study of input and output resistance in amplifiers.
3. Study of Bloc3king oscillator.
4. Study of TRF receiver and signal tracer.
5. Study of Pulse generation
6. Study of scaling units.
7. Study of clipping and clamping circuits.
8. Study of Video amplifier

Design and Construction of:

9. Scaling Unit
10. Preamplifier
11. Public address system amplifier.
12. Phase sensitive detector.

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