SYLLABUS FOR M. Sc. COURSE IN PHYSICS

KHALLIKOTE UNITARY UNIVERSITY

BRAHMA VIHAR, BRAHMAPUR-760 001

Website:kuu.ac.in

With effect from 2023-24

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-I	4	20	80
5		105	PRACTICAL (Computational Physics)	6	20	80
6	II	201	Mathematical Methods in Physics	4	20	80
7		202	Electrodynamics-II & Plasma Physics	4	20	80
8		203	Quantum Mechanics-II	4	20	80
9		204	Atomic & Molecular Physics	4	20	80
10		205	PRACTICAL (Optics, Electricity & Magnetism & Electronics)	6	20	80
11	III	301	Statistical Mechanics-I	4	20	80
12		302	Nuclear Physics-I	4	20	80
13		303	Relativistic Quantum Mechanics	4	20	80
14		304	Special Paper (Electronics)-I	4	20	80
15		305	PRACTICAL (Modern Physics)	6	20	80
16	IV	401	Statistical Mechanics-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 (Modern Physics)	6	20	80
	Total			88	400	1600

M. Sc. PHYSICS **SEMESTER I** **DURATION : 03 HOURS**

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.

PAPER-101 Classical Mechanics

Objectives of the Course

Students will be able to

1. Know the physical concepts and familiar with classical mechanics and also its mathematical form. Solving problem of different systems using classical mechanics.
2. To demonstrate the knowledge and understanding the concept of the dynamics of system of particles, Lagrangian and Hamiltonian formulation of mechanics for complicated mechanical systems.

Unit-I Kinematics of Rigid Body Motion

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

Unit-II Variational Principle

1. Legendre transformation.
2. The Hamilton's equation of motion from a variational principle.
3. Conservation theorem and the physical significance of Hamiltonian.
4. The principle of least action.

Unit-III Canonical Transformations

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

Unit - IV Small Oscillations

1. The Hamilton Jacobi equation for Hamilton's principal function.
2. The harmonic oscillator problem as an example of H.J. Method, Kepler problem.
3. Small oscillations, formulations of the problem, the eigen value equation, and the principal axis transformations .
4. Frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.

Learning Outcomes

1. Understand the basic mechanical concepts related to discrete and continuous mechanical systems.
2. Understand complex kind of gyroscopic motion as like heavy symmetric top.
3. Describe and understand planar and spatial motion of a rigid body and understand the motion of amechanical system using Lagrange-Hamilton formalism.
4. Demonstrate a working knowledge of classical mechanics and its application to standard problems such as central forces.

SUGGESTED READINGS

1. Cassiday GL and Fowles GR (2005) Analytical Mechanics, Cengage Learning, USA.
2. Chand S and Mathur DS (2000) Mechanics, Company Limited, New Delhi.
3. Dieter Strauch (2009)Classical Mechanics: An introduction, Springer, Paris.
4. Frank NH, Spiegel MR, (2006) Theoretical Mechanics, Tata McGraw Hill, USA.
5. Goldstein H, Poole CP, Safko JL (2011) Classical Mechanics, Pearson Education, UK.
6. Goldstein Hilbert, Pooles Charles P, and Safko John L (2011) Classical Mechanics, Pearson Education, UK.
7. Jewett JW, Serway RA (2017) Physics for scientists and Engineers with Modern Phys, Cengage Learning, USA.
8. Kleppner D, Kolenkow RJ (2017) An Introduction to Mechanics, McGraw-Hill, USA.
9. Landau LD and Lifshitz EM (1982) Mechanics, Pergamon, UK.
10. Prakash Satya (2014) Mathematical Physics, Sultan Chand, New Delhi.
11. Reese Ronald Lane (2003) University Physics, Thomson Brooks/Cole, Wisconsin.
12. Resnick R (2007) Introduction to Special Relativity, JohnWiley and Sons, USA.

M. Sc. PHYSICS **SEMESTER I** **DURATION : 03 HOURS**

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.

PAPER-102 Electrodynamics –I

Objectives of the Course

Students will be able to

1. Study the Maxwell's wave equation in different dielectric media and free space
2. Understand vector and scalar potential and their importance in electromagnetics
3. Study electromagnetic energy transport and Poynting vector
4. Understand Lorentz and Coulomb gauge conditions, covariant form of Maxwell's equation.
5. Study laws of geometrical optics using Maxwell's equation
6. Study Kramer Kronig relation on reflection and absorption of electromagnetic wave
7. Study and understand propagation of electromagnetic waves in different types of waveguides.
8. Study of retarded potential and solving it by Green's Function techniques for different types of charge
9. distributions
10. Study electric, magnetic dipole and quadrupole radiation
11. Study electromagnetic radiation due to moving point charge and accelerated charge

Unit-I Inhomogeneous wave equation

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

Unit-II Wave Guides

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

Unit-III Radiation-I

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

Unit-IV Radiation-II

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

Learning Outcomes:

1. Demonstrate and analyze Maxwell's wave equation in different media.
2. Derive scalar and vector potential in presence of different sources.
3. Derive the Poynting theorem.
4. Apply Gauge invariance condition to Maxwell's equation.
5. Derive Maxwell's equation in co-variant form.
6. Derive covariant form of Maxwell's equations.
7. Derive relation between reflection coefficient and absorption coefficient.
8. Calculate different modes of electromagnetic waves in waveguides.
9. Calculate angular distribution of radiation and power emitted by dipole.
10. Show that accelerating charge produce electromagnetic radiation.

SUGGESTED READINGS

1. Chopra and Agrawal (2021) Electromagnetic theory & Electro dynamics, Kedarnath and ramnath Company, Meerut.
2. Chow TL (2010) Introduction to Electromagnetic Theory, Jones & Bartlett Learning, Massachusetts.
3. Edminster JA (2006) Electromagnetics, Schaum Series , Tata McGraw Hill, USA.
4. Edward Purcell M (2013) Electricity and Magnetism, McGraw-Hill Education, USA.
5. Fewkes JH &Yarwood Jn (2012) Electricity and Magnetism, Vol. I,. Oxford University Press, UK.
6. Feynman RP, Leighton RB, Sands M (2012 Feynman Lectures Vol.2, Pearson Education, UK.
7. Griffiths DJ (2024) Introduction to Electrodynamics, Cambridge university press, UK.
8. Gupta Kumar and Singh (2023)Electrodynamics, Tata-McGrawhill, USA.
9. Guru B and Hiziroglu H (2009) Electromagnetic field theory fundamentals, Cambridge University Press, UK.
10. Hecht E (2019) Optics, Pearson India, UK.
11. Jackson JD (2007) Classical Electro dynamics, John Wiley & Sons, USA.
12. Kshetrimayun RS (2011) Electromagnetic field Theory, Cengage Learning, USA.
13. Lehner G (2010) Electromagnetic Field Theory for Engineers & Physicists, Springer Education, Paris.
14. Lorrain P & Corson D (1987) Electromagnetic Fields & Waves, Freeman W.H & Co, USA.
15. Mahajan S. and Choudhury (2017) Electricity, Magnetism & Electromagnetic Theory, McGraw-Hill, USA.
16. Miah MAW (1982) Fundamentals of Electromagnetics, Tata McGraw Hill Education, USA.
17. Panofsky WKH and Phillips Melba (1962) Classical Electricity and Magnetism, Addison-Wesley Publishing Company, USA.
18. Puri SP (2016) Classical Electro dynamics, Alfa science international limited, UK.
19. Sadiku MNO (2007) Elements of Electromagnetics, Oxford University Press, UK.
20. Tayal DC (2014) Electricity and Magnetism, Himalaya Publication, Mumbai.

M. Sc. PHYSICS **SEMESTER I** **DURATION : 03 HOURS**

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.

PAPER 103 QUANTUM MECHANICS-I

Objectives of the Course

Students will be able to
1. Study postulates and formalism of quantum mechanics.
2. Study operator formulation of quantum mechanics.
3. Study time evolution of a state and operator and apply Schrodinger equation to 1D harmonic oscillator.
4. Study operator algebra of orbital angular momentum and spin angular momentum operator.
5. Study motion in spherical symmetric potential and apply Schrodinger equation to solve hydrogen atom.

Unit–I General Principles of Quantum Mechanics

1. Linear vector space, Ket and Bra vectors, scalar product of vectors.
2. The Kronecker and Dirac delta function, Linear Operators, Adjoint, Unitary Operators, Expectation values of dynamical variables and physical interpretation, Hermitian Operators.
3. Eigen Values and eigen vector, Orthonormality of eigen vectors, Probability interpretation, Degeneracy, Schmidt method of orthogonalisation.
4. Representation of Ket and bra vectors and operators in matrix form, Unitary transformations of basis vector and operators.

Unit–II Quantum-dynamics

1. Schrödinger’s Equation of time, evolution of quantum states.
2. Schrödinger picture, Heisenberg picture, Interaction picture, Equation of motion.
3. Operator formalism, Postulates of Quantum Mechanics, operator method solution of Harmonic oscillator.
4. Matrix representation and time evolution of creation and annihilation operators.

Unit–III Orbital Angular Momentum

1. 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.
2. Eigen value of L^2 and L_z with respect to Spherical harmonics.
3. Raising and Lowering operators, Orbital angular momentum wave function.
4. 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

1. Spin 1/2 Particles, Pauli-spin matrices and their properties, eigen values and eigen functions.
2. Spinor transformations under rotation.
3. Angular momentum matrices,Add matrices, Addition of angular momenta, Total angular momentum *J*.
4. Eigen value problem of J_{z}&J, Clebsch Gordon Coefficients and their values for J1 = 1/2,J2=½ and J1=1and J2=1/2.

Learning Outcomes

1. State basic postulates of quantum mechanics.
2. Understand the Hermitian operators, projection operators, unitary operators etc.
3. Solve Schrodinger equation of harmonic oscillator problem completely using operator method.
4. State addition of angular momentum theorems and spin angular momentum statistics
5. Solve for the hydrogen atom using Schrodinger equation.
6. To apply quantum mechanics to the dynamics of single particle in one-,,two and three-dimensional potential fields.
7. To strengthen the analytical abilities of the student and help them to apply it in different branches of physics compactly.

SUGGESTED READINGS

1. Aruldhas G (2008) Quantum Mechanics, PHI Learning of India, New Delhi.
2. Bohm Arno (1993) Springer, Quantum Mechanics: Foundations & Applications, USA.
3. Cameron RB (2007) Quantum Mechanics, Jones and Bartlett Learning,UK.
4. Das M, Jena PK (2009) Introduction to Quantum Mechanics, Prakashan SriKrishna, Merrut.
5. Dicke H, Robert & Wittke JP (1960) Introduction to Q M., Addison Wesley Publishing Company,USA.
6. Eisberg, Robert and Resnick, Robert (2002) Quantum Mechanics, John Wiley Publication, USA.
7. Gasiorowicz S (2012) Quantum Physics, Wiley India, USA.
8. Ghatak A (2012) Basic Quantum Mechanics, Mc Millan India.
9. Ghatak AK & Lokanathan S (2004) Quantum Mechanics: Theory & Applications, Springer publication, Paris.
10. Greiner Walter (2001) Quantum Mechanics, Springer, Paris.
11. Mathews PM and Venkatesan K (2010) A Text book of Quantum Mechanics, Hill McGraw, USA.
12. Merzbacher Eugen (2004) Quantum Mechanics, Wiley John and Sons,USA.
13. Miller DAB (2008) Quantum Mechanics for Scientists & Engineers, Cambridge University Press, UK.
14. Powell JL and Craseman B (2015) Quantum Mechanics, Narosa Publishing House, Mumbai.
15. Roman P (1965) Advanced QM, Addison Wesley Publishing Company,USA.
16. Schiff LI (2017) Quantum Mechanics. Hill Tata McGraw, USA.
17. Tannoudji B Diu B and F Laloë F (1977) Quantum Mechanics (2 vols) Wiley-VCH 977- Cohen, UK.
18. Wichman EH (1971) Quantum Physics, Berkeley Physics, Vol.4., Hill Tata McGraw, USA.

M. Sc. PHYSICS **SEMESTER I** **DURATION : 03 HOURS**

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

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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.

PAPER 104 SOLID STATE PHYSICS

Objectives of the Course

1. Students will be able to:
2. Understand Energy gap in solid
3. Experimental method for the Fermi surface study
4. Understand the electron-electron interaction
5. Understand the Transport properties
6. Magnetic properties

Unit–I BandTheory

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

Unit-II Energy Bands

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

Unit–III Representation Theory and Semiconductor

1. Wannier functions, equation of motion in Wannier representation.
2. Equivalent Hamiltonian and impurity levels.
3. Intrinsic and extrinsic semiconductor, Laws of mass action.
4. Hall effect, Intrinsic carrier concentration, Mobility in the in trinsic region.

Unit-IV Imperfections in crystals &Solid State Devices

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

Learning Outcomes

1. Explain the significance and value of condensed matter physics, both scientifically and inthe wider community.
2. The subject treats materials from an experimental viewpoint, solid state theoryand properties.
3. Understanding of the interplay between classical – and quantum mechanical phenomena, incondensed matter physics.
4. Demonstrate the electron-phonon interaction and second quantization.
5. Understand electron –ion interaction for energy gap in solid

SUGGESTED Readings

1. Aschroft and Mermin (2021) Solid State Physics,John wiley and sons, USA.
2. Ashcroft NW, Mermin (1976) Solid State Physics,Cengage Learning, USA.
3. Dekker AJ (2008) Solid State Physics, MacMillan publishers india Ltd, USA.
4. Ghatak and Thyagarajan (2019) LASERS: Fundamentals and Applications, McMillan India.
5. Ibach H, Luth H (2009) Solid-state Physics, Springer, Paris.
6. Kittel C (2019) Introduction to Solid State Physics, John wiley and sons, USA.
7. Laud BB (2010) Lasers and Non linear Optics ,Wiley Eastern, USA.
8. Leonid V Azaroff (2014) Introduction to Solids, Tata Mc-Graw Hill, USA.
9. Omar A (1993)Solid State Physics ,Addison-wesley publishing house, USA.
10. Omar M Ali (2002) Elementary Solid State Physics, Pearson India.
11. Pillai SO (2022) Solid State Physics, New Age Publication, New Delhi.
12. Puri RK & Babbar VK (2010) Solid State Physics- S.Chand Publication, Merrut.
13. Shur Michael (1990) Physics of Semiconductor Devices,PHI, USA.
14. Srivastava JP (2014) Elements of Solid State Physics, Prentice-Hall of India
15. Wahab MA (2015) Solid State Physics, Narosa Publications, Mumbai.

M. Sc. PHYSICS **SEMESTER I** **DURATION : 06 HOURS**

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.

PAPER-105 (PRACTICAL)

1. Preliminaries of running computers taking out print out etc.
2. Exercises to study various features of C-Language.

M. Sc. PHYSICS **SEMESTER II** **DURATION : 03 HOURS**

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.

PAPER 201 Mathematical Methods of Physics

Objectives of the Course

1. It will provide students with basic skills necessary for the application of mathematical methods in physics.
2. Introduction of various existing mathematical methods in order to analyses theories, methods and interpretations.
3. Develop understanding among the students how to use methods within his/her field of study of research and in the field of scientific knowledge to work independently.

Unit-I Complex variables and Delta function

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

Unit-II Special Functions

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

Unit-III Tensors

1. Covariant, contravariant and mixed tensors.
2. Rank of a tensor, symmetric and anti symmetric tensors, invariant tensor, epsilon tensor.
3. Pseudo tensors, properties of tensor, metric tensor, raising and lowering of tensors.
4. Covariant derivative, Christoffel symbols.

Unit-IV Group Theory

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

Learning Outcomes

1. Demonstrate the utility and limitations of a variety of powerful calculation techniques and to provide a deeper understanding of the mathematics and useful in theoretical physics.
2. Understand elementary ideas in linear algebra, special functions and complex analysis.
3. Will be able to apply these to solve problems in classical, statistical and quantum mechanics, electromagnetism as well as solid state physics.

Suggested Readings

1. Arfken B, HarrisF E Weber HJ (2012) Mathematical Method for Physicists,lsevier.
2. Chattopadhyay PK (2022) Mathematical Physics,New age int. publishers.
3. Coddington (2009) Introduction ordinary differential equations, PHI learning.
4. George F Simmons (2017) Differential Equations, Hill McGraw..
5. Mathews and Walker (1971) Mathematical Methods of Physics,Pearson.
6. McQuarrie, DA (2008) Mathematical methods for Scientists and Engineers, Viva Book.
7. Nearing James (2010) Mathematical Tools for Physics, Dover Publications.
8. Prakash atya (2014) Mathematical Physics,S Chand Publications.
9. Wright ,WS and Zill, DG(2016),6th Ed, Advanced Engineering Mathematics , Jones and Bartlett Learning.

M. Sc. PHYSICS **SEMESTER II** **DURATION : 03 HOURS**

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.
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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.

PAPER-202 Electrodynamics and PlasmaPhysics-II

Objectives of the Course

Students will be able to

1. Study the Maxwell’s wave equation in different dielectric media and free space
2. Understand vector and scalar potential and their importance in electromagnetics
3. Study electromagnetic energy transport and Poynting vector
4. Understand Lorentz and Coulomb gauge conditions, covariant form of Maxwell’s equation.
5. Study laws of geometrical optics using Maxwell’s equation
6. Study Kramer Kronig relation on reflection and absorption of electromagnetic wave
7. Study and understand propagation of electromagnetic waves in different types of waveguides.
8. Study of retarded potential and solving it by Green’s Function techniques for different types of charge
9. distributions
10. Study electric, magnetic dipole and quadrupole radiation
11. Study electromagnetic radiation due to moving point charge and accelerated charge
12. Occurrence of plasma

Unit-I Radiation, Scattering & Dispersion

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

Unit-II Diffraction and Covariant Formulation

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

Unit-III Covariant form of Maxwell's equation

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

Unit-IV Plasma

1. Introduction, Conditions for plasma existence,Occurrence of plasma.
2. 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.
3. Magneto hydrodynamics.

4. Magnetic confinement-Pinch effect. Instabilities in pinched plasma column.
5. Plasmawaves.

Learning Outcomes
Students will be able to

1. Demonstrate and analyze Maxwell's wave equation in different media.
2. Derive scalar and vector potential in presence of different sources.
3. Derive the Poynting theorem.
4. Apply Gauge invariance condition to Maxwell's equation.
5. Derive Maxwell's equation in co-variant form.
6. Derive covariant form of Maxwell's equations.
7. Derive relation between reflection coefficient and absorption coefficient.
8. Calculate different modes of electromagnetic waves in waveguides.
9. Calculate angular distribution of radiation and power emitted by dipole.
10. Show that accelerating charge produce electromagnetic radiation.
11. Occurrence of plasma.

SUGGESTED READINGS

1. Capri AZ & Panat PV(2002) Introduction to Electrodynamics , Alpha Science, USA.
2. Choudhury and Mahajan S (2012) Electricity, Magnetism & Electromagnetic Theory, Tata Mc Graw, USA.
3. Fewkeys JH & Yarwood J (1991), Electricity and Magnetism , Oxford University Press, UK.
4. Feynman RP, Leighton RB, Sands M Vol-2 (2008) Feynman Lectures, Pearson Education, UK.
5. Griffths DJ (1998) Introduction to Electrodynamics , Benjamin Cummings,UK.
6. Hecht E (2016) Optics, Person, UK.
7. Jackson JD (1999) Classical Electrodynamics, Wiley India, USA.
8. Purecell, Edward M (1986) Electricity and Magnetism , McGraw-Hill Education, USA.
9. Sadiku, MNO (2010) Elements of Electromagnetics, Oxford University Press, UK.
10. Taysl DC (2014) Electricity and Magnetism, Himalaya Publication ,Mumbai.

M. Sc. PHYSICS **SEMESTER II** **DURATION : 03 HOURS**

20 Mid Term+80 End Term = Full Marks100

Pattern of questions in Term End Examination

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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.

PAPER-203 QUANTUMMECHANICS-II

Objectives of the Course

Students will be able to:

1. Understand the importance of perturbation theory in quantum mechanics
2. Study time independent and time dependent perturbation theory and apply those to various physical
3. problem
4. Understand fine structure of hydrogen atom, Stark effect, Zeeman effect,
5. Understand interaction of radiation with matter, selection rules
6. Understand quantum mechanical description of scattering
7. Understand variational principle and its application.

Unit–I Central Forces

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

Unit–II Approximation Method-I

1. Time independent perturbation theory (Non degenrate and degenrate).
2. Removal of degenracy, Linear and quadratic Stark effect.
3. Normal and anomalous Zeeman effect, Fine structure of spectral lines of H-Like atoms.

Unit-III Approximation Method-II

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

Unit–IV Scattering

1. Scattering amplitude and cross section.
2. Born approximation, Application to coulomb and Screened coulomb potentials.
3. Partial wave analysis for elastic and inelastic scattering, optical theorem, Scattering from a hard sphere.

Learning Outcomes

Students will be able to

1. Derive energy and wave function for physical system using time independent perturbation theory.
2. Derive transition probability under time dependent perturbation theory.
3. Explain Stark effect, origin of polarizability and dipole moment, fine structure of hydrogen atom.
4. Zeeman effect.
5. Understand the dipole selections rules in various atomic transitions.
6. Solve the scattering cross-section for various scattering process such as black sphere scattering, hard sphere.
7. scattering and inelastic scattering.
8. Apply variational principle to find out the ground state energy of the various physical system.

Suggested Readings

1. Aruldhas G (2002) Quantum Mechanics , PHI Learning of India,New Delhi.
2. Bohm, Arno (1993) Quantum Mechanics: Foundations & Applications, Springer, Paris.
3. Craseman B and Powell JL (1988) Quantum Mechanics , Narosa, New Delhi.
4. Das M, Jena, PK (2009) Introduction to Quantum Mechanics, Sri Krishna Prakashan, Merrut.
5. Eisberg, Robert and Resnick Robert (2002) Quantum Mechanics , Wiley, USA.
6. Gasiorowicz S (2013) Quantum Physics, Wiley, USA.
7. Mathews, PM and Venkatesan K (1976) A Text book of Quantum Mechanics, Mc-Grawhill Education, USA.
8. Miller DAB (2008) Quantum Mechanics for Scientists & Engineers, Cambridge University Press, USA.
9. Reed, Bruce Cameron (2008) Quantum Mechanics , Jones and Bartlett Learning, USA.
10. Schiff, Leonard I (2010) Quantum Mechanics ,Tata McGraw Hill, USA.

M. Sc. PHYSICS **SEMESTER II** **DURATION : 03 HOURS**

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.

PAPER-204 ATOMIC AND MOLECULAR PHYSICS

Objectives of the Course
Students will be able to:

- Magnetic behaviour of solid
- Types of defects
- Know about types of superconductor
- Know the properties of semiconductor materials
- Know the properties of superconductor and high Tc superconductor
- Solid state devices

Unit–I Review of one electron and Many electron atoms

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

Unit – II Interaction with Electromagnetic fields & Molecular structure

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

Unit–III Molecular spectra

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

Unit–IV Atomic collisions & Resonance Spectroscopy

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

Learning Outcomes

- ✓ Understand the magnetic behaviour of solid
- ✓ Understand the types of defects
- ✓ Understand the difference in normal conductor and superconductor
- ✓ Derive Specific heat equation for the metal and insulator
- ✓ Derive the Law of mass action relation for the semiconductor material
- ✓ Understands the Cooper pair and energy gap in superconductor
- ✓ Solid state devices

SUGGESTED READINGS

1. Aruldhas G (2012) Molecular Structure & Spectroscopy, PHI Learning Pvt.Ltd.
2. Bernstein, Fishbane, and Gasiorowicz (2010) Modern Physics, Pearson India.
3. Bernstein Jeremy, Fishbane Paul, Stephen Gasiorowicz (2000) Modern Physics, Pearson Education
4. Dubson MA, Taylor JR, Zafiratos CD (2003) Modern Physics, PHI Learning.
5. Eisberg R (2012) Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley India.
6. Gasiorowicz, Stephen (2007) Quantum Physics, Wiley John & Sons.
7. Gerhard Herzberg (2003) Atomic Spectra & Atomic Structure, Translated by JWT Spinks, Dover Publications, New York.
8. Krane, Kenneth S (2011) Modern Physics, Wiley-India Edition.
9. Satyanarayana DN (2021) Vibrational Spectroscopy, Theory & Applications, New Age International Publishers.
10. Saxena AK(2014) Principles of Modern Physics , Narosa Publishing House.

M. Sc. PHYSICS **SEMESTER II** **DURATION : 06 HOURS**

20 Mid Term+80 End Term = Full Marks100

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

P– 205

PRACTICAL

Full Marks:100

Duration:6 hours

Optics,Electricity,MagnetismandElectronics

1. Experiments with Ballistic Galvanometer
   I. Determination of constants of the Galvanometer by:
   II. Hibbert Magnetic standard
   III. Solenoid Inductor
   IV. Condense or discharge method
   V. Measurement of Magnetic field by search coil
2. Anderson's Bridge
3. Heaviside Bridge
4. Maxwell's Bridge
5. Carey-Foster Bridge
6. Rayleigh’s Bridge
7. Owen's Bridge
8. DielectricConstantofaliquidbyelectricallymaintainedtuningfork.
9. B-HCurve,Oscilloscopicdisplay

10. Characteristicsofvacuumtubesandtransistors.

11. Diode,TriodeandPentode

12. Settingupanoscillator(A.F.&R.F.)

13. Settingupofanamplifierandstudyofitscharacteristics.

14. Settingofpowersupply

15. LCRBridge

16. MichelsonInterferometer

17. FabryparotInterferometer.

18. Babimet'sCompensator

19. Bimirror

20. Straightedge.

M. Sc. PHYSICS SEMESTER III DURATION : 03 HOURS

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.

PAPER-301 STATISTICAL MECHANICS-I

Objectives of the Course

- Understand postulates of classical and quantum statistical mechanics
- Study different formalism of statistical physics such as microstate, macrostate and ensembles
- Understand the Boltzmann and Gibb's interpretation of entropy.
- Study Fermi-Dirac statistics and Bose-Einstein statistics
- Understand phase transitions and Ising model to study ferromagnetism

Unit–I Classical Statistical Mechanics

1. Postulates of classical statistical mechanics.
2. Liouville's theorem, Micro canonical ensemble.
3. Derivation of thermodynamics, Equipartition theorem, classical idealgas.
4. Gibb's paradox.

Unit-II Ensembles

1. Canonical ensemble and energy fluctuation.
2. Grand canonical ensemble and density fluctuation.
3. Equivalence of canonical and grand canonical ensemble.

Unit–III Quantum Statistical Mechanics

1. Postulates of Quantum statistical mechanics.
2. The density matrix.
3. Ensembles inquantum statistical mechanics.

Unit-IV Quantum Ensembles

1. Third law of thermodynamics.

2. Ideal gas in microcanonical.
3. canonical and Grand canonical ensemble.

Learning Outcomes

- ✓ State postulates of classical and quantum statistical mechanics
- ✓ Differentiate between microstate and macrostate
- ✓ Tell the significance Gibb's paradox and indistinguishability in statistical mechanics
  Describe Planck's blackbody radiation relation, electronic specific heat in metals and Bose-Einstein condensation

Suggested Readings

1. Beale Paul D & Pathria RK (2011) Statistical Mechanics
2. Das Palash (2012) An introduction to Equilibrium Statistical Mechanics: I.K.International Publication.
3. Gambhir RS and Lokanathan S (1991) Statistical and Thermal Physics, Prentice Hall
4. Helrich Carl S (2010) Modern Thermodynamics with Statistical Mechanics,Springer
5. Huang K (1987) Statistical Mechanics
6. Kardar M (2007) Statistical Physics of Particles- (CUP)
7. Mandl F (2012) Statistical Physics -- (CBS)
8. Patharia RK (1972) Statistical Mechanics .
9. Reif F (2010) Statistical Physics, Berkeley Physics Course,Tata McGraw-Hill
10. Swendsen RH (2012) An Introduction to Statistical Mechanics & Thermodynamics,Oxford Univ. Press.

M. Sc. PHYSICS SEMESTER III DURATION : 03 HOURS

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.

PAPER-302 NUCLEAR PHYSICS-I

Objectives of the Course

- Introduce students to the fundamental principles, concepts governing nuclear physics and decay process.
- To impart knowledge about nuclear deformations, properties and nuclear models for understanding of related reaction dynamics.

Unit-I Nuclear properties & deuteron

1. Introduction: Brief discussion of Nuclear properties.
2. The two body nuclear problem, the deuteron (ground and excited state).
3. Tensor forces, magnetic and quadrupole moments of deuteron, Exchange property of nuclear force.

Unit-II Neutron proton scattering

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

Unit-III Nuclear Models

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

Unit-IV Nuclear Disintegration Studies

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

Learning Outcomes

- ✓ Explain the different forms of radioactivity and account for their occurrence
- ✓ Master relativistic kinematics for computations of the outcome of various reactions and decay processes.

Account for the fission and fusion processes.

Suggested Readings

1. Blatt JM & Weisskopf VF (1991) Theoretical Nuclear Physics, (Dover Pub.Inc)
2. Bransden (2003) Physics of Atoms and Molecules, Pearson India.
3. Das A and Ferbel T (2002) Introduction to Nuclear and Particle Physics,World Scientific.
4. Elton (1965) Introductory Nuclear theory
5. Ghosh Dipak ,Gupta A B (2001) Atomic and Nuclear Physics , Books and Allied Publishers.
6. Gracia and Henley (2012) Subatomic Physics ,World Scientific.
7. Heyde K (2002) Basic ideas and concepts in Nuclear Physics,Institute of Physics Pub.
8. Heyde K (2004) Basic ideas and concepts in Nuclear Physics - An Introductory Approach (IOP-Institute of Physics Publishing,).
9. Knoll GF (2000) Radiation detection and measurement, John Wiley & Sons.
10. Nigam & Roy (2014) Nuclear Physics
11. Tayal DC (2015) Nuclear Physics

M. Sc. PHYSICS SEMESTER III DURATION : 03 HOURS

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.

P-303

RELATIVISTICQUANTUMMECHANICS

Objectives of the Course

- Understand the importance Covariant form

Understand Klein-Gordon equation, Dirac equation in relativistic quantum mechanics

Unit-I Relativistic Equations

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

Unit-II Properties of Dirac Equation-I

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

Unit-III Properties of Dirac Equation-II

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

Unit-IV Discrete Symmetries

1. Equivalence of representations, Standard representation.
2. Trace identities, Invariance of Dirac equation under proper Lorentz transformations.
3. Space inversion, time inversion.
4. charge conjugation. Bilinear covariants .

Learning Outcomes

- ✓ Students will have achieved the ability to:
- ✓ Explain the relativistic quantum mechanical equations, namely, Klein-Gordon equationand Dirac equation.

Describe second quantization and related concepts.

SUGGESTED READINGS

1. Drell and Jorken (2001) Relativitic Quantum Mechanics –Relativitic Quantum Mechanics – JG Sackurai.
2. Mathews PM and Venkatesan, K (2010) A Text book of Quantum Mechanics, McGraw Hill.
3. Eisberg, Robert and Resnick, Robert (2002) Quantum Mechanics, Wiley.
4. Schiff Leonard I (2010) Quantum Mechanics, Tata McGraw Hill.
5. Aruldhas G (2002) Quantum Mechanics, PHI Learning of India.
6. Bartlett and Jones (2008) Reed Bruce Cameron Quantum Mechanics, , Jones and Bartlett Learning.
7. Bohm, Arno (1993) Quantum, Mechanics: Foundations & Applications, Springer
8. Gasiorowicz S (2013) Quantum Physics---- (Wiley India) .

M. Sc. PHYSICS **SEMESTER III** **DURATION : 03 HOURS**

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.

PAPER-304 Special Paper(Electronics) -I

Objectives of the Course

- Understand Different type of Amplifiers using Hybrid parameters
- Understand types of modulation
- Understand operational principle, model and analysis of various operational amplifiers
- Understand the working, model and analysis of various digital circuits
- Understand model and analysis of radio communication and antenna

Understand working principles of fiber optics

Unit-I Feedback amplifiers

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1. Series current and voltage feedback amplifier.
2. Oscillators : Negative resistance oscillators - dynatrontunnel–diodes.

Unit-II Modulation

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

Unit–III Microwaves

1. Principle of velocity modulation theory and operation of Klystron.
2. Magnetron, Characteristics of microwave diodes and cavity resonator.
3. AFC (Automatic Frequency Control) of microwaves

Unit–Iv Antenna theory & Quantum Electronics

1. Radiations from doublet antenna, Radiation field of a dipole vertical wire antenna, image antennas, Directivity of antenna array.
2. Yogi and Rhombic antenna.
3. Radiation resistance and Power impedance matching.
4. Fibre optics- Principles of optical communication
5. Basic Principle of Maser action, spontaneous and stimulated emission-important Maser devices

Learning Outcomes

- ✓ Explain frequency response of linear amplifiers, feedback amplifier
- ✓ Explain and design differential amplifier, sum and integrator etc
- ✓ Explain feedback criteria for oscillation, crystal-controlled oscillator, Klystron oscillator, principle of
- ✓ Explain basic principles wave propagation

SUGGESTED READINGS

1. Avadhanulu M.N. An introduction to Laser -
2. Chand S. & selfvast Co.Laser Fundamentals - William,
3. Gupta and Kumar Hand Book of electronics
4. Khare R.P. Fibre Optics and Optoelectronics -
5. Leach, D.P. , Malvino, A.P., and Saha, 2011, Digital Principles and Applications, 7th Ed., Tata McGraw
6. Malvino Digital Principles and Application
7. Ramana Functional Electronics
8. Reich Microwave Principle -
9. Sarkar Microwave Technology
10. Shur Michael Physics of Semiconductor Devices - (PHI).
11. Trunde Operational Amplifier
12. Yariv Optical Electronics

M. Sc. PHYSICS **SEMESTER III** **DURATION : 06 HOURS**

20 Mid Term+80 End Term = Full Marks100

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

PAPER-305 PRACTICAL

Special Paper (Electronics)

Each student must complete at least fifteen experiments with electron tubes.(Each examinee has to pick up one experiment by lottery)

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. Copitt's Oscillator
8. An Hartley Oscillator
9. Study of gates.
10. Zener diode.

Experiment with Transistor:

1. FET Characteristics
2. Study of input and output resistance in amplifiers.
3. Study of Blocking 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:

1. Scaling Unit
2. Preamplifier
3. Public address system amplifier.
4. Phase sensitive detector.
5. Pulse generator.
6. Noise generator.
7. Narrow band width amplifiers.

M. Sc. PHYSICS SEMESTER IV DURATION : 03 HOURS

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.

PAPER-401 STATISTICALMECHANICS-II

Objectives of the Course

- Study Fermi-Dirac statistics and Bose-Einstein statistics

Understand phase transitions and Ising model to study ferromagnetism

Unit–I Ideal Fermi gas

Equation of state of an Ideal Fermi gas, Theory of white dwarf stars,Landau diamagnetism, Pauli para magnetism.

Unit–II Ideal Bosegas

IdealBosegas,PhotonsandPlank'slaw,phononsandDebye'stheoryofspecificheat,Bose-Einsteincondensation,liquidHe.

Unit-III PhaseTransitions

Landau theory of phase transition,TheoryofYANGandLee,condensationofvander Waalsgas.

Unit-IV The Ising Model

Definition of the Ising model, One-dimensional Ising model.

Learning Outcomes

- ✓ Describe Planck's blackbody radiation relation, electronic specific heat in metals and Bose-Einstein condensation
- ✓ Describe thermodynamics of phase transition and formulate the Ising model of phase transitions

SUGGESTED READINGS

1. Das, Palash (2012) An introduction to Equilibrium Statistical Mechanics: I.K.International Publication.
2. Gambhir, RS and Lokanathan S (1991) Statistical and Thermal Physics, Prentice Hall
3. Helrich, Carl S Modern (2009) Thermodynamics with Statistical Mechanics, Springer
4. Kardar M (2007) Statistical Physics of Particles- CUP
5. Mandl F (2012) Statistical Physics .CBS
6. Reif ,F., 2008, Statistical Physics, Berkeley Physics Course, Tata McGraw-Hill
7. Swendsen R.H., 2012, An Introduction to Statistical Mechanics & Thermodynamics, Oxford Univ. Press.

M. Sc. PHYSICS SEMESTER IV DURATION : 03 HOURS

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.

PAPER-402 NUCLEARPHYSICS& PARTICLEPHYSICS-II

Objectives of the Course

- The students gather advanced knowledge in Nuclear physics
- The different nuclear interactions and the corresponding nuclear potentials and itsdependence on thecouplings are learned.
- The knowledge about nuclear and particle Physics.
- Basic knowledge about the nuclear reaction

Understand the meaning and importance of the terms: quark

Unit-I □decay

1. □decay,Fermi's theory of □□□decay, Kurie plot and □-ray spectrum.
2. Parity violation of - decay, allowed and forbidden transitions, selection rules.
3. □ transition, interaction of □□rays with matter, Pair production, internal conversions.

Unit-II Nuclear reaction & Mechanism

1. Nuclear reaction, reaction energetics, Q-value equation. Direct compound nuclear reaction.
2. Cross sections in terms of partial wave, amplitudes. Compound nucleus - Scattering matrix.
3. Reciprocity theorem - Breit Wigner one level formula Resonance Seattering.

Unit-III Particle Physics-I

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

Unit-IV Particle Physics-II

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

Learning Outcomes

- ✓ The course gives an understanding of the nucleus at low energy.
- ✓ The students develop basics to solve some of the problems of nuclear physics and their limitations innature.
- ✓ The course gives an understanding of the fundamental nuclear particles

More Idea about quark model.

SUGGESTED READINGS

1. Blatt JM & Weisskopf V F (1991) -Theoretical Nuclear Physics, Dover Pub.Inc.
2. Concepts of nuclear physics Cohen Bernard L Cohen (1998) Concepts of nuclear physics, Tata Mcgraw Hill.
3. Griffith DJ (2010) -Introduction to Elementary Particles, WileyJohn & Sons.
4. Heyde K (2004) An Introductory Approach by -Basic ideas and concepts in Nuclear Physics .
5. Krane, Kenneth S Krane (2008)-Introductory nuclear Physics, Wiley India Pvt. Ltd.,
6. Perkins, DH (2009) Introduction to High Energy Physics, Cambridge Univ. Press

M. Sc. PHYSICS SEMESTER IV DURATION : 03 HOURS

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.

P -403
QUANTUMFIELDTHEORY

Objectives of the Course

- Understand Quantization of free fields
- Understand the Feynman diagrams in configuration and momentum space
- Understand Lagrangian and Hamiltonian Formulations, Noether’s theorem

Unit– I Lagrange formalism for relativistic classical field

- Variation principle and Euler Lagrange equations.
- Definition of field,Secondquantization,Symmetricsandconservationlaws,Noether'stheorem,energy-momentumtensor,angularmomentum.

Unit-II

LagrangiandensityforKlein–Gordon,DiracandMaxwellfields,Internalsymmetry,Invarianceunderphasetransformationsandconservationofvectorcurrent(charge),Localgauge transformations.

Unit-III

Quantization of free fields and particle interpretation: Real and Complex K –Gfield,Canonicalquantizationandcommutationrelationsforcreationandannihilation operators, Energy, momentum and charge of the quantized field, Diracfield, positivity of energy and anticommutation relations, Bosons and Fermions,antiparticles,Relativisiticcovarianceofcanonical quantization.

Unit-IV

Interactionofquantizedfields:Unequalspace-timecommutationandanti-commutation relations, Properties of delta function and its integral representations,vacuumexpectionvalue,normalorder,Time-orderedproduct,Dyson'schronologicalproductandWick'schronologicalproduct,S-matrix,Wick'stheorem,FeynmandiagramandRules,electron-photoninteraction,ComptonScattering,CoulombScattering.

Learning Outcomes

- ✓ Describe second quantization and related concepts.
- ✓ Feynmandiagrams, S-matrix.

SUGGESTED READINGS

- Itzykson and Zuber Quantum Field Theory
- Ryder L. H.Quantum Field Theory
- Schweber Quantum Field Theory
- Mandel and Shaw ,Quantum Field Theory
- Schiff ,Leonard I., 3rd Edn. 2010, Quantum Mechanics, Tata McGraw Hill.
- Aruldhas, G., 2nd Edn. 2002, Quantum Mechanics, PHI Learning of India.
- Reed, Bruce Cameron, 2008, Quantum Mechanics, Jones and Bartlett Learning.
- Bohm, Arno, 3rd Edn., 1993, Quantum Mechanics: Foundations & Applications, Springer.
- Miller, D.A.B., 2008, Quantum Mechanics for Scientists & Engineers, Cambridge University Press.
- Greiner, Walter., 2001, Quantum Mechanics, 4th Edn., Springer.
- Mandl, F. ,2013,Quantum Mechanics - (CBS) .
- Laloë, Diu B ,Laloë F Cohen-,1977, Quantum Mechanics (2 vols) Wiley-VCH .
- David, J. Griffith., 2005, Introduction to Quantum Mechanics, Pearson Education.
- Ghatak, A.K. & Lokanathan, S., 2004, Quantum Mechanics: Theory & Applications, Macmillan
- Wichman, E.H., 1971, Quantum Physics, Berkeley Physics, Vol.4. Tata McGraw-Hill Co.

M. Sc. PHYSICS **SEMESTER IV** **DURATION : 03 HOURS**

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.

PROJECT

P-404

M. Sc. PHYSICS **SEMESTER IV** **DURATION : 06 HOURS**

20 Mid Term+80 End Term = Full Marks100

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

P– 405

PRACTICAL(MODERNPHYSICS)

Marks:100

Duration:6hrs.

(Eachexamineehastopickup oneexperimentbylot)

- e/mbyMillikan's oildrop experiment
- e/mbyvariousmethods:a) Braun Tubemethod b) Magnetronvalvemethod c) Helicalmethod
- Determinationof'h'byvarious methods:a)Photoelectric effect method b) TotalRadiationMethodusingopticalPyrometers
- Measurementofvelocityoflightanddielectricconstantby Lecherwire.
- G.M.counterexperiments:a) DeterminationofcharacteristicsofGeigertube b) Determinationof absorptioncoefficient
- StudyofliquidsbyultrasonicspectrometerVelocityofultrasonicwavesinliquids
- VerificationofRichardson'sLaw-Thermionicemission.
- DeterminationofmagneticsusceptibilityofdifferentsamplesbyHelmholtzcoil method.
- Settingupandstudyinganamplifier.
- Studyof MossbauerEffect.

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