YBN UNIVERSITY

Established by the Act of Government of Jharkhand Act 15, 2017
Gazette Notification No. 505, Dated 17th July 2017
As per Section 2(f) of UGC Act. 1956

YBN UNIVERSITY, RANCHI (JHARKHAND)

UNIVERSITY DEPARTMENT OF PHYSICS

SCHOOL OF SCIENCE

M.Sc. Programme in Physics

(Based on CBCS Pattern)

Detailed Guideline and syllabus for two years (24 Months) M.Sc.

Programme in Physics 2020 onwards

APPROVED BY
THE BOARD OF STUDIES
UNIVERSITY DEPARTMENT OF PHYSICS
SCHOOL OF SCIENCE
YBN UNIVERSITY, RANCHI (JHARKHAND)

Our Vision:

Vision of the Physics department is to lay the foundational stone of excellence and spur development of the University as a premier Institution in the field of Physics, by igniting and nurturing enthusiasm, interests and passion, among the students through the advanced curricula.

Our Mission

1: To provide quality training to the students for Physics education and equip them with skills required for higher studies in International and National institutions of great repute.
2: To motivate young minds and unravel their talents both in the fields of Theoretical and Experimental Physics, through dedication to teaching, commitment to students and innovative teaching learning methods and assessment throughout the year.
3: To provide the students state of the art knowledge through upgraded and advanced curricula, hands on training in state of the art laboratories and in high end computation and simulation to make them competent from a global perspective.
4: To enable the students having a clear perspective of ongoing research activities in different fields of Physics .
5: To prepare the students ready for industry oriented jobs by having hands on training through "Summer Internship" program in different reputed Companies or Research Organizations.
6: To bridge the skill gaps and make students industry ready and relevant and dutiful towards society, by adding various value added courses like "Design Thinking", "Venture Ideation", "Human Values and Ethics"etc.
8: To evolve strategies in the Department for continuous Improvement in all aspects of academic and administrative issues.

Introduction to the Program:

The program M.Sc. Physics is a beginning step towards a flourishing career. For students who have completed their graduation with Physics as core subject, and who want to pursue their career as a brilliant Physicist in different domains of Physics and Applied Physics, this course should be the very next logical step. This course brings forth all the domains of Physics, along with its recent developments starting from the beginning, with proper mathematical rigor through detailed analytical calculations, realization of the theoretical propositions through various laboratory experiments and computational simulations. Inclusion of Projects, Dissertations, Seminars on Contemporary Research in Physics, Summer Internships in various industries and reputed Research Organizations will help the students to think outside the box and igniting the young minds with scientific inquisitiveness.

Specializations Offered in Second Year:

Electronics
Condensed Matter Physics &
Advanced Quantum Mechanics

Program Educational Objective:

01: : Post-graduates shall have successful careers in academia, research based organizations or different Government/Non-Government sectors.
02: Students shall develop approaches with a concern for accuracy and precision in significance to science and technology.
03:Students shall identify, formulate and solve scientific problems based on design, experiment, data interpretation and analysis of results.
04:Investigate various problems and ways to solve which will be very beneficial to society.
Program Outcome:
01: Theoretical knowledge of Physics: Apply theoretical knowledge of principles and concepts of Physics to practical problems.
02: Scientific Accuracy and Precision: Develop approaches with a concern for accuracy and precision in significance to science and technology, i.e., develop the ability to critically evaluate theories, methods, principles, and applications of pure and applied science.
03: Computer Simulation Knowledge: Visualize and verify the Theoretical predictions/propositions of Physics through Computer Simulation.
04: Experimental design and Data Interpretation: Identify, formulate and solve scientific problems based on design, experiment, data interpretation and analysis of results .
05: Societal benefit Investigate various problems and ways to solve which will be very beneficial to society.
06: Usage of Modern Tools: Show ability in using modern tools for design and analysis.
07: Meet the realistic demands: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.
08: Ethical Practice: Understand and practice professional ethics
09: Multidisciplinary Focus: Work in teams on multi-disciplinary projects in research organizations and industries.
10: New Challenges: Take up new challenges to understand the reasoning of any physical phenomena through research and design solutions to meet the societal as well as scientific demands.
11:Scientific Reporting: Demonstrate the ability to undertake a major, individual, physics-related project and reporting the results in a full scientific report and oral and poster presentation.
12: Effective Communication: Build up communication skills, both written and oral, to specialized and non-specialized audiences.

Programme Eligibility:

Qualified B.Sc. in Physics or equivalent examination from any UGC approved University or Universities at abroad having equivalent curriculum with 50% marks .

GENERAL GUIDELINES

1. M.Sc. Course in Physics shall be of two years duration.

2. There shall be semester wise examination.

3. There shall be four semester (04) in two years, Semester-I and Semester-II in first year (1^{st} year) and Semester-III and Semester-IV in the second year (2^{nd} year).

4. There shall be three theory papers of 100 marks each of THREE HOURS duration and one practical exam of 100 marks of THREE HOUR duration in each Semester-I, II & III. In Semester-IV, there will be one PROJECT WORK of 100 MARKS. There shall be a Mid Term Examination also in each Semester of 20 marks in each theory papers.

5. There shall be 11 theory papers, 4 practical papers and 1 Project Work altogether.

6. There shall be THREE GROUPS of optional elective paper, out of which student has to elect ONE GROUP.

   GROUP OF ELECTIVE PAPERS:

   Group-A : ELCTRONICS
   Group-B : CONDENSED MATTER PHYSICS
   Group-C : ADVANCED QUANTUM MECHANICS

(a) Each theory paper in each END SEMESTER EXAMINATION shall carry SEVENTY (70) as FULL MARKS.

(b) There shall be MID SEMESTER EXAMINATION/ INTERNAL EVALUATION in the middle of each Semester carrying THIRTY (20) as FULL MARKS.

(c) There shall be total EIGHT (08) questions in each End-Semester Examinations. Examinees are required to answer any FIVE (05) questions out of EIGHT (08).

(d) The duration of End-Semester Examination shall be of THREE (03) HOURS in each theory paper of each Semester.

Course Structure for M.Sc. Programme in Physics

SEM	COURSE OPTED	Paper	Distribution of Marks			
			END SEM	MID SEM	PRACTICAL / PROJECT	TOTAL
I	FC (Compulsory) – (FC-I)	1	70(50+20)	30	-	100
	Core Course – 1 (CC-1)	2	70(50+20)	30	-	100
	Core Course – 2 (CC-2)	3	70(50+20)	30	-	100
	Core Course (P) – 3 [CC (P)-3]	4	-	-	100	100
II	Core Course-4	5	70(50+20)	30	-	100
	Core Course – 5	6	70(50+20)	30	-	100
	Core Course – 6	7	70(50+20)	30	-	100
	Core Course (P) – 7 [CC (P)-7]	8	-	-	100	100
III	Core Course – 9	9	70(50+20)	30	-	100
	Core Course – 9	10	70(50+20)	30	-	100
	Core Course-10	11	70(50+20)	30	-	100
	Core Course (P) – 11 [CC (P)-11]	12	-	-	100	100
IV	Core Course – 12	13	70(50+20)	30	-	100
	Elective (GE/DC) (EC-1)	14	70(50+20)	30	-	100
	Elective (GE/DC) (EC-2)	15	-	-	100	100
	Elective Course (P) –[EC (P)]	16	-	-	100	100

Semester-wise Distribution of Course

SEM	COURSE	CREDIT	Hrs./Week
I	FC (Compulsory) – (FC-I)	5	5(L)+1(T)
	Core Course – 1 (CC-1)	5	5(L)+1(T)
	Core Course – 2 (CC-2)	5	5(L)+1(T)
	Core Course (P) – 3 [CC (P)-3]	5	10
II	Core Course-4	4	5(L)+1(T)
	Core Course – 5	5	5(L)+1(T)
	Core Course –6	6	5(L)+1(T)
	Core Course (P) – 7 [CC (P)-7]	5	10
III	Core Course – 8	4	5(L)+1(T)
	Core Course – 9	6	5(L)+1(T)
	Core Course-10	5	5(L)+1(T)
	Core Course (P) – 11 [CC (P)-11]	5	10
IV	Core Course – 12	4	5(L)+1(T)
	Elective (GE/DC) (EC-1)	5	5(L)+1(T)
	Elective (GE/DC) (EC-2)	5	5(L)+1(T)
	Elective Course (P) –[EC (P)]	6	10

COURSE STRUCTURE OF M.Sc PHYSICS FIRST SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2PHY 101	Foundation Course(Compulsory)	Environmental Studies	100	50	17	20	07	30	10	5	0	-	5
1Y2PHY 102	Core Course-I	Classical Physics & Relativity	100	50	17	20	07	30	10	5	1	-	5
1Y2PHY 103	Core Course-II	Quantum Mechanics-I	100	50	17	20	07	30	10	5	1	-	5
1Y2PHY 104P	Core Course-III Practical	Atomic Physics Practical	100	50	17	20	07	30	10	-	-	5	5
	Grand Total		400										20

Minimum Passing Marks are equivalent to Grade D

Lectures T- Tutorials P- Practical, Major- Term End Theory Exam

Minor- Pre University Test

Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

Syllabus of Foundation Course
SEMESTER I
PAPER-I
COURSE CODE : 1Y2PHY101
ENVIRONMENTAL STUDIES
CREDIT : 05

Unit – I : Fundamental of Environmental Studies :
(a) Definition scope and importance
(b) Need for public awareness
  I. Institutions in environment
  II. People in environment
(a) Concept of Atmosphere, Hydrosphere, Lithosphere and Biosphere.

Unit- II : Natural resources :
(a) Natural resources and associated problems
(b) Role of an individual in conservation of Natural resources
(c) Equitable use of resources for sustainable lifestyle.

Unit- III : Ecosystems:
(a) Concept
(b) Structure and function of freshwater & forest ecosystem
(c) Energy flow
(d) Food chain, Food-web and ecological pyramids.

Unit- IV : Biodiversity and its conservation:
(a) Definition, genetic, species and ecosystem diversity
(b) Biogeographical classification of India
(c) Threats to biodiversity
(d) Endangered and endemic species of India
(e) Conservation of Biodiversity

Unit- V : Environmental pollution and Social issues:
(a) Definition, causes, and effects of Air, Water and pollution.
(b) Disaster Management—Flood, Earthquakes & Cyclones.
(c) Social issues:
  (i) From unsustainable to sustainable development
  (ii) Water conservation and rain water harvesting
  (iii) Environmental Ethics, issues and possible solution.
(d) Environmental and human health
(e) Women and child welfare.

SEMESTER I

CORE COURSE-I
COURSE CODE : 1Y2PHY102
PAPER-II
Classical Physics & Relativity

Unit 1: Vector space and matrices, Representation of linear transformations and change of base, Eigen values and Eigen vectors, Diagonalization of a matrix.

Unit 2: Properties of Fourier series, integral transforms, development of Fourier integrals, Laplace transforms, First and Second shifting theorems.Analyticity and Cauchy- Reimann conditions, Cauchy's integral theorem and formula, Taylor's series and Laurent's series expansion, Zeros and singular points, Residues, Cauchy's residue theorem,, Evaluation of definite integrals.

Unit 3:Constraints and their classification, D'Alemberts principle, generalized coordinates and momenta, Lagrange's equation of motion, symmetries of space and time with conservation laws, Hamilton's functions and Hamilton's equation of motion.

Unit 4:Rotating frames, inertial frames, applications of Coriolis force.Central force, Definitions and characteristics of two body problem, Closure and stability of circular circular orbits,General analysis of orbits, Kepler's law and equation.

Unit 5: Lorentz transformations; 4-vectors, Tensors, transformation properties, Metric tensor, Covariant and Contravariant derivatives, Christofel symbol, and Levi-Civita symbol,Equivalence principle, Derivation of Einstein field equation, Schwarzschild solution, gravitational red shift, deflection of light due to gravitational field, motion of Planetary orbits.

Books Recommended:

Mathematical Methods for Physics by G. Arfken
Matrices and Tensors for Physicists by A. W. Joshi
Advanced Engineering Mathematics by E. Kreyszig
Complex variable M.R.Spigel (Schaum series)
Complex variables and applications, V Ed R.V. Churchill and J.W. Brown (McGraw)
Mathematics for Physicists by Mary L. Boas
Mathematical Methods in Classical and Quantum Physics by Tulsi Dass And Sharma (University Press)
Classical mechanics by Rana and Jog (TMH)
Classical mechanics by H. Goldstein (Addison and Wesley)
Classical mechanics and general properties of matter by S.Maiti and D P Raychaudhary (New Age)
Classical mechanics by J. C. Upadhya (Himalya Publication)
Relativistic Mechanics by M. Ray (S. Chand)
Theory of relativity by R. S. Mishra
Relativistic Mechanics by Satya Prakash
Relativistic Mechanics by Goel & Gupta

CORE COURSE-II
COURSE CODE : 1Y2PHY103
PAPER-III
Quantum Mechanics I

Unit 1: Review of concepts: Analysis of double slit particle diffraction experiment; the De Broglie hypothesis; Heisenberg Uncertainty Principle, probability waves, Postulates of Quantum Mechanics, Observables and operators, measurements, the state function and expectation values, the time dependent Schrodinger equation, time development of state functions, solution to the initial value problem, Superposition and Commutation: the superposition principle, commutation relations, their connection to the uncertainty principle, degeneracy, complete set of commuting observables, Time development of state functions and expectation values, conservation of energy, linear momentum, and angular momentum, parity.

Unit 2: Dirac notation, Hilbert space, Hermitian operators and their properties, Matrix mechanics: Basis and representations; matrix properties, unitary and similarity transformations, the energy representation, Schrodinger, Heisenberg and interaction pictures.

Unit 3: General properties of one dimensional Schrodinger equation, Particle in a box, Harmonic oscillator, unbound states, one- dimensional barrier, Finite potential well.

Unit 4: Orbital angular momentum operators in Cartesian and spherical polar coordinates, commutation and uncertainty relations, spherical harmonics, Two particle problem- coordinate relative to the centre of mass, radial equation for a spherically symmetric potential, hydrogen atom, eigen values and radial eigen functions, degeneracy, probability distribution.

Unit 5: Time independent perturbation theory, First and second order corrections to the energy eigen values, first order correction to the eigen vector, Degenerate perturbation theory, Application to one electron system – Relativistic mass correction, Spin orbit coupling (L-S and j –j), Zeeman effect and Stark effect.
Variational method: He atom as example, First order perturbation, Exchange degeneracy.

Books Recommended :

Quantum Mechanics by L. I. Schiff (McGraw-Hill)
Quantum physics S. Gasiorowicz (Wiley)
Quantum Mechanics by B. Craseman and J D Powell (Addison Wesley)
Modern quantum mechanics by JJ Sakurai
Quantum Mechanics by Ghatak & Loknathan (MacMillan)
Quantum Mechanics by S.N. Biswas (Books and Allied)
Quantum Mechanics by Satya Prakash
Quantum Mechanics by Merzbecher
Quantum Mechanics by Tannuodji, Diu and Laloe (Wiley-VCH)

PAPER IV

COURSE CODE : 1Y2PHY104P

ATOMIC PHYSICS PRACTICAL

Experiments:

1. Determination of wavelength of sodium light with the help of Biprism.
2. Determination of wavelength of sodium light with the help of Bimirror.
3. Diffraction at an straight edge
4. Refractive index of glass prism by spectrometer
5. Determination of Cauchy's constants.
6. Determination of wavelength of light by diffraction grating
7. Resolving power of the given prism
8. Resolving power of diffraction grating
9. Verification of Brewster's law
10. Experiments on constant deviation spectrometer
11. Experiments on Michelson Interferometer
12. Experiments on Fabry Perot Interferometer

COURSE STRUCTURE OF M.Sc PHYSICS SECOND SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subjectwise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2PHY201	Core Course -IV	Electronics	100	50	17	20	07	30	10	4	-	-	4
1Y2PHY202	Core Course -V	Quantum Mechanics -II	100	50	17	20	07	30	10	5	-	-	5
1Y2PHY203	Core Course -VI	Atomic Molecular & Laser Spectroscopy	100	50	17	20	07	30	10	6	-	-	6
1Y2PHY204P	Core Course VII-Practical	Electricity & Electronics Practical	100	50	17	20	07	30	10	-	-	5	5
	Grand Total		400										20

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

CORE COURSE-IV
COURSE CODE : 1Y2PHY201
ELECTRONICS

Unit 1:
Semiconductor Devices: BJT, JFET, MOSFET (Enhancement and depletion types), UJT, SCR, TUNNEL Diode, Zener Diode-structure, working and charcteristics.

Unit 2:
Operational Amplifier : Block diagram, Characteristics of OP-AMP, Inverting and noninverting amplifier, adder, subtractor, differentiator. integrator, current voltage converter, Differentiating amplifier, CMRR Inverting and non-inverting amplifier.

Unit 3:
Oscillators: Principles, Barkhausen criterion, Phase shift oscillator, Wien-bridge oscillator, negative resistance and LC tunable oscillator, Crystal oscillator, Monostable and astable multovibrator.
Unit 4:
Digital Electronics : Number systems and codes, Binary arithmetic, Logic gates – AND, OR, NAND, NOR, NOT, XOR, Boolean algebra theorems, De-Morgan’s Theorem, Half and full adders.
Flip –flops: RS flip flop, Master slave, J K flip- flop.

Unit 5:
p-n junction: Fabrication of p-n junction by diffusion and ion implantation, abrupt and linearly graded junctions, Thermal equilibrium conditions, depletion regions, depletion capacitance, Capacitance voltage (C-V) characteristics, evaluation of impurity distribution, varactor, ideal and practical current voltage (I-V) characteristics, tunnelling and avalanche reverse junction breakdown mechanisms, minority carrier storage, diffusion capacitance, transient behaviour, ideality factor and carrier concentration measurements, Carrier life time measurement by reverse recovery of junction diode, p-i-n diode, tunnel diode, Introduction to p-n junction solar cell and semi conductor laser diode.

Books Recommended:
Semiconductor Devices – Physics and Technology by SM Sze Wiley (1985)
Introduction to Semiconductor devices by, M. S. Tyagi, (John Wiley and Sons)
Measurements, Instrumentation and Experimental Design in physics and Engineering by M.Sayer and A. Mansingh (Prentice Hall, India-2000)
Electronic Principle by Malvino (TMH)

SEMESTER II
CORE COURSE-V
COURSE CODE : 1Y2PHY202
QUANTUM MECHANICS II

Unit 1:
WKB approximation, Quantisation rule, tunnelling through a barrier, qualitative discussion on α -decay, Time dependent perturbation theory and transition probability.

Unit 2:
Laboratory and centre of mass frames, differential and total scattering cross section, scattering amplitude, Scattering by spherically symmetric potentials, Partial wave analysis and phase shifts, Scattering by a rigid sphere and square well; Coulomb scattering; Formal theory of scattering – Green function in scattering theory, Lippman- Schwinger equation, Born Approximation.

Unit 3:
Meaning of identity and consequences; Symmetric and anti symmetric wave functions, Slater determinant, Symmetric and antisymmetric spin wavefunctions of two identical particles, Collision of identical particles.

Unit 4:
Ladder operators, eigenvalues and eigenfunctions of L^2 and L_z, using spherical harmonics, angular momentum and rotations, Total angular momentum J; L-S coupling; eigenvalues of J^2 and J_z; Addition of angular momentum, Clebsch- Gordan coefficients for $j_1=j_2=1/2$ and $j_1=1$, $j_2=1/2$, coupled and uncoupled representation of eigenfunctions; Angular momentum matrices, Pauli spin matrices, spin eigenfunctions; free particle wavefunctions including spin, addition of two spins.

Unit 5:.
Klein – Gordon equation, Feynman-Stuckelberg interpretation of negative energy states and concept of antiparticles, Dirac equation, covariant form, adjoint equation; Plane wave solution and momentum space spinors, Spin and magnetic moment of the electron, Non relativistic reduction. Helicity and chirality, Properties of γ matrices, Charge conjugation; Normalisation andcompleteness of spinors.

Books Recommended :

Quantum Mechanics by L. I. Schiff (McGraw-Hill)

Quantum Physics S. Gasiorowicz (Wiley)

Quantum Mechanics by B. Craseman and J D Powell (Addison Wesley)

Modern quantum mechanics by JJ Sakurai

Quantum Mechanics by Ghatak & Loknathan (MacMillan)

Quantum Mechanics by S.N. Biswas (Books and Allied)

Quantum Mechanics by Satya Prakash

Quantum Mechanics by Merzbacher

CORE COURSE-VI
COURSE CODE : 1Y2PHY203
ATOMIC, MOLECULAR & LASER SPECTROSCOPY

Unit 1:

Spectroscopic terms and their notations, Quantum states, Atomic orbital; Parity of the wave function, Angular and radial distribution functions, Spin orbit interaction, quantum mechanical relativity correction; Lamb shift, Zeeman effect, Normal and anomalous Zeeman effect, Paschen- Back effect, Stark effect.

Unit 2:

Weak fields and strong field effects, quantum mechanical treatment of stark effect. Hyperfine structure of spectral lines: Nuclear spin and hyperfine splitting, intensity ratio and determination of nuclear spin. Breadth of spectral lines, natural breadth, Doppler effect.

Unit 3:

Independent particle model: He atom as an example of central field approximation,; Central field approximation for many electron atom; Slater determiant; L-S and j-j coupling; Equivalent and non equivalent electrons; Energy levels and spectra; Spectroscopic terms: Hunds rule; Lande interval rule; Alkali spectra.

Unit 4:

Rotational spectra of a diatomic molecule as a rigid rotator, Vibrational energy of a diatomic molecule, Diatomic molecule as a simple harmonic oscillator, Energy levels and spectrums, Morse potential energy curve; PQR branches.

Unit 5:

Basic elements of a laser, Threshold condition, Population inversion, Pumping mechanism – optical pumping, Rate Equations for three level and four level Laser-system, Ruby Laser, Nd – YAG Laser, Semiconductor laser, carbon-dioxide laser, optical fibers – light wave communication. Einstein's A and B coefficients.

Books Recommended :

Introduction to atomic spectra by H. E. White (T)
Fundamentals of Molecular spectroscopy by C.B.Banwell(T)
Speroscopy vol.I II III by Walker and Straughen
Introduction to molecular spectroscopy by G.M. Barrow
Spectra of diatomic molecules by Herzberg
Molecular spectroscopy by Jeanne L. Mchale
Molecular spectroscopy by J. M. Brown
Spectra of atoms and molecules by P. F. Bemath
Laser Physics – by Laud
Laser spectroscopy by Demtroder
Non-linear laser spectroscopy by Letekhov
Laser Physics by Ghatak And Thyagarjan

CORE COURSE-VII
COURSE CODE : 1Y2PHY204P
ELECTRICITY AND ELECTRONICS PRACTICAL

Experiments:

1. Experiment to show the functioning of Diode as a rectifier.
2. Characteristics of an n-p-n transistor.
3. Characteristics of a p-n-p transistor
4. Characteristics of a diode/ zener diode ,SCR
5. Logic gate
6. Verification of DeMoiver's theorem
7. Verification of truth tables of Half/Full adder
8. Characteristics of FET/MOSFET
9. Series and Parallel resonance circuit
10. Anderson bridge
11. De sauty/Carey foster Bridge.

COURSE STRUCTURE OF M.Sc PHYSICS THIRD SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subjectwise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2PHY301	Core Course-VIII	Condensed Matter Physics	100	50	17	20	07	30	10	4	-	-	4
1Y2PHY302	Core Course-IX	Nuclear Physics	100	50	17	20	07	30	10	6	-	-	6
1Y2PHY303	Core Course-X	Computational Physics & Programming	100	50	17	20	07	30	10	5	-	-	5
1Y2PHY304P	Core Course-XI Practical	Computational Physics Practical	100	50	17	20	07	30	10	-	-	5	5
	Grand Total		400										20

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER III

CORE COURSE-VIII

COURSE CODE: 1Y2PHY301

CONDENSED MATTER PHYSICS

Unit 1:

Crystals symmetry and symmetry operation, 5-fold axis of rotation is not possible, X-ray diffraction, Laue's equation, Bragg equation, Derivation of Bragg equation from Laue's equation, Lattice vibration.

Unit 2:

Vibrations of monoatomic lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, Quantization of lattice vibrations, phonon momentum, Inelastic scattering of neutrons by phonons. Thermal conductivity- Lattice thermal resistivity, Umklapp process.

Unit 3:

Dieletrics, Polar and non-polar dielectrics, Lorentz field, Clausius Mosotti equation, Polarization, Different polarizabilities.

Unit 4:

Brand theory of solids, Kronig Penny model, Brillouin zones.Semiconductors, intrinsic and extrinsic semiconductors, calculation of electron and hole concentration in a pure semiconductor, PN diode acts as a rectifier, transistor

Unit 5: Quantum theory of Ferromagnetism and Antiferromagnetism.Superconductivity, Meissner effect, London's equation, Elements of BCS theory, Josephson effect. Mossbauer effect, concept, classical theory of Mossbauer effect and its application in brief.

Books Recommended:

Introduction to solid state physics by Kittel
Elementary solid state physics by Omar
Solid state physics by A. J. Dekker
Solid state physics by Aschroft and Mermin
Principles of condensed matter physics by Chaikin and Lubensky
Band theory and electronic properties of solids by Singleton
Crystallography for solid state physics by Verma and Srivastava

CORE COURSE-IX

COURSE CODE: 1Y2PHY302

NUCLEAR PHYSICS

Unit 1:

Basic nuclear properties: nuclear size, Rutherford scattering, nuclear radius and charge distribution, nuclear form factor, mass and binding energy, Angular momentum, parity and symmetry, Magnetic dipole moment and electric quadrupole moment.

Unit 2:

Nucleon – Nucleon interaction- Deuteron problem, Exchange forces and tensor forces, Meson theory of Nuclear forces, Nucleon- Nucleon scattering – Low energy n-p scattering, Effective range theory, Low energy p-p scattering.

Unit 3:

Beta decay: Fermi theory of Beta decay, Shape of spectrum, Angular momentum and parity, selection rules, Two component theory of neutrino decay, Detection and properties of neutrino.

Gamma decay: Interaction of gamma rays with matter, Multipole radiations, Angular momentum and parity, selection rules, internal conversion.

Unit 4:

Direct and compound unclear reaction mechanism, Cross section in terms of partial wave amplitude, Liquid drop model; Bethe- Weizsaccker binding energy/mass formula, Bohr – Wheeler theory of Nuclear fission.

Shell Model – experimental evidence in favour of Shell model, Magic numbers spin, magnetic moments.

Unit 5:

Elementary Particles : Classification of elementary particles, Types of interaction between elementary particles, Hadrons and Leptons, Symmetry and conservation laws, Elementary ideas of CP and CPT invariance, classification of Hadrons, SU(3) multiplets, Quark Model (Gell- Mann, Okubo mass formula for octet and decuplet Hadrons, Bottom top Quarks

<u>Books Recommended :</u>

Nuclear structure, vol-1, and vol-2 by A. Bohr and B. R. Mottelson
Introductory Nuclear physics – by K. S. Krane (Wiley)
Atomic and nuclear physics , vol-2 by Ghoshal
Concepts of nuclear physics by Cohen
Nuclear physics by Roy and Nigam
Atomic Nucleus by R D Evans
Quarks and Leptons by F. Halzen and A. D. Martin.

CORE COURSE-X

COURSE CODE: 1Y2PHY303

COMPUTATIONAL PHYSICS & PROGRAMMING

Unit 1:

Methods for determination of zeroes of linear and non linear algebraic and transcendental equations, the graphic methods, the bisection method, Reguli – Falsi method, Newton Raphson methods, Newton Raphson method applied to polynomial equations, Iteration method, convergence of solutions.

Unit 2:

Solutions of simultaneous linear equations, Gaussian elimination method, Gauss Jordan method, Iterative method, Gauss Siedel iteration method, Matrix inversion method.

Unit 3:

Curve fitting, polynomial least square method.

Finite differences method, Interpolation with evenly spaced and unevenly spaced points.

Unit 4:

Numerical differentation and intergration, Trapezoidal rule, Simpson's 1/3 and 3/8 rules, Newton Cotes formula, Gauss integration method, Numerical solutions of differential equations, Euler and Runge Kutta method, Milne's predictor and corrector formula, Solutions of practical differential equation (five point formula).

Unit 5:

Flow charts, Algorithms, Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non- executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Operating systems, Creation of executable programs.

Books Recommended:

Numerical Analysis by Rajaraman

Mathematical Methods of physics by Mathews and Walker (Pearson)

Numerical Analysis by Shankar Rao (PHI)

Fortran Progrmming Raja Ramanna (PHI)

CORE COURSE-XI PRACTICAL

COURSE CODE: 1Y2PHY304P

COMPUTATIONAL PHYSICS PRACTICAL

Experiments:

1. Determination of roots of a function
2. Inversion of a matrix
3. Solutions of Eigen value problem
4. Solution of a linear simultaneous equation
5. Numerical differentiation and integration
6. Solution of a first order differential equation
7. Interpolation and extrapolation
8. Least square fitting
9. Fortran Programming
   (a) Constants and variables
   (b) Assignment and arithmetic expressions
   (c) Logical expressions and control statements
   (d) DO loop, array, input and output statements
   (e) Function, subprogram, subroutine

COURSE STRUCTURE OF M.Sc PHYSICS FOURTH SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max. Marks	Min. Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2PHY401	Core Course-XII	Electrodynamics & Plasma Physics	100	50	17	20	07	30	10	4	-	-	4
1Y2PHY402	Elective Course-I	Electronics/Condensed Matter Physics/Advanced Quantum Mechanics[Paper-I]	100	50	17	20	07	30	10	5	-	-	5
1Y2PHY403	Elective Course-II	Electronics/Condensed Matter Physics/Advanced Quantum Mechanics[Paper-II]	100	50	17	20	07	30	10	5	-	-	5
1Y2PHY404P	Elective Course Practical	Elective Course Practical	100	-	-	-	-	-	-	-	-	6	6
	Grand Total		400										20

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER IV
CORE COURSE-XII
COURSE CODE: 1Y2PHY401
ELECTRODYNAMICS & PLASMA PHYSICS

Unit 1:

Electromagnetic field tensor in Four dimensions and Maxwell's Equations, Dual field tensor, Wave Equation for vector and scalar potential and solution, Retarded Potential and Lienard Wiechert Potential

Unit 2:

Invariance of Maxwell's equations under Lorentz transformation, Transformation properties of field quantities, covariant equation of motion of particles in electromagnetic field, Energy momentum tensor, Radiation from a moving charged particle

Unit 3:.

Electromagnetic field tensor in four dimensions, Maxwell's equations, Dual field tensor, Wave equation for vector and scalar potential and solution.

Unit 4:

Plasma Physics: Macroscopic and microscopic properties of plasma, Debye shielding distance, Plasma oscillation, Motion of charged particle in uniform electric and magnetic fields, Motion in non uniform electric and magnetic fields, Motion in time varying electromagnetic field.

Unit 5:

Adiabatic invariants; Plasma confinement, pinch effect, Derivation of momentum equation, Boltzman equation.

Books Recommended:

Plasma physics by Chen
Classical electrodynamics – Jackson
Classical electricity and magnetism by Panofsky and Philips
Plasma physics by Bittencourt
Introduction to plasma physics by R P Sinha and B Naraian (Novelty)

COURSE CODE: 1Y2PHY402

(ELECTIVE) PAPER I

ELECTRONICS-I

Unit 1:

Amplifier: Differential amplifier, Rejection of common mode signal, operational amplifier, slew rate, inverting and non-inverting amplifier

Unit 2:

Communication Electronics: General theory and frequency spectrum of A.M. and F.M., F.M. generation by reactance modulator, SSB modulation

Unit 3:

Digital Electronics: Sequential logic circuits, Flip flop, S-R, J-K, D type flip-flop, Data selector: Multiplexer, encoder and decoder, analog to digital and digital to analog conversion, Memories: ROM, PROM, EAROM & RAM

Unit 4:

Microprocessors: Fundamental of microprocessor and Microprocessor functioning, Organization of microprocessors, Signal description of microprocessors, 8085 microprocessor.

Unit 5:

Introduction to optical fibers, wave propagation and total internal reflection in optical fiber, structure of optical fiber, types of optical fiber, numerical aperture, acceptance angle, single and multimode optical fibers, optical fiber materials and fabrication.

Books Recommended:

Electronic Devices and circuit theory by Robert Boylested and Louis Nashdsky (PHI)
OP-Amps and Linear integrated circuits by Rama kanth and A. Gayakward (PHI)
Digital principles and applications by A.P. Malvino and Donald Laach (TMH)
Microprocessor Architecture, Programming and applications with 8085/8086 by Ramesh S. Gaonakar.
Optical fiber communications, Kaiser G. McGraw Hill, Int. Student Ed. Besides, Books on general Electronics.

OR,

COURSE CODE: 1Y2PHY402

(ELECTIVE) PAPER I

CONDENSED MATTER PHYSICS-I

Unit 1:

Dislocations and Defects in crystals: Point defects and planar (stacking) faults, observation of imperfections in crystal, x-ray and electron microscope technique.

Unit 2:

Charge density oscillations in non-magnetic alloys, Friedel sum rule, Macroscopic theory of optical property of solids, complex refractive index, Kramers- Kroing relations, Dispersion and absorption.

Unit 3:

Experimental study of Fermi surfaces, Cyclotron resonance, De Hass van Alphen effect, Anomalous skin effect.

Unit 4:

Band theory of solids, Nearly free electron approximation, Zone schemes, Tight binding model.

Unit 5:

Electrical conductivity of thin films, Difference of behaviour of thin films from bulk, Boltzman transport equation for a thin film (for diffused scattering), Expression for electrical conductivity.

<u>Books Recommended:</u>

Elementary dislocation theory by Weertman and Weertman

X-ray crystallography –Azaroff

The interpretation of X-ray diffraction phtographs-Henry et al

Solid state physics - Kittel

Solid state physics – Ashcroft and Mermin

Theory of solids – J M Ziman.

Besides, books on general Condensed matter physics.

OR,

COURSE CODE: 1Y2PHY402

(ELECTIVE) PAPER I

ADVANCED QUANTUM MECHANICS-I

Unit 1:

Covariant form of Dirac equation, Invariance of Dirac equation under Lorentz transformation, Transformation matrix for parity transformation and time reversal transformation, Charge conjugation as symmetry transformation, Zitterbewgung of electron, Spin orbit energy of electron, zero mass Dirac equation.

Unit 2:

Elements of classical theory of fields, Euler Lagrange equation of motion for the fields, Lagrangian and

Hamiltonian for scalar field, Schrodinger field, Dirac field and electromagnetic field.

Unit 3:

Introduction to path Integrals, Generating functional for scalar fields, Functional integral, Free particle Green's function, Generating functional for interacting fields: ϕ^4 theory. Effective action for ϕ^4 theory. Two point functions, Four point functions, Grassman variable, Fermionic functional integrals and generating functional

Unit 4:

Propagator and gauze condition in QED, Photon propagator, Propagator for transverse photon, Scattering cross section for some elementary process in QED

Unit 5:

Divergence in ϕ^4 theory, Dimensional regularization, Renormalization of ϕ^4 theory, Divergence in QED, Electron self energy, Vaccum polarization, WT identities, Anomalous magnetic moment of electron. Renormalization group equations.

Books Recommended:

Relativistic quantum fields by Bjorken and Drell
Quantum mechanics by B K Agrawal
Advanced quantum mechanics by Sakuari
Particle physics and introduction to field theory by Lee
Mesons and fields by Schweber, Bethe and Hoffmann.
Introduction to QFT: F. Mandle and G. Shaw
Quantum Field Theory: L.H. Ryder
Besides, books on general Quantum Mechanics.

OR,

COURSE CODE: 1Y2PHY403

(ELECTIVE) PAPER II

ELECTRONICS - II

Unit 1:

Microwave characteristics features & application, Waveguides and Cavity Resonators, two cavities Klystron, Refex Klystron, Semiconductor Gunn diode characterstics, Microwave antenna, Detection of microwave

Unit 2:

Devices and communications: Principles of velocity modulation, Basic principles of two cavity Klystrons and Reflex Klystrons, Travelling wave tubes, Principles of operation of megnetrons.

Unit 3:

Transmission line and Wave-guides: Basic line equation, General solution for a line terminated by impedance, Reflection coefficient and V.S.W.R. Propagation through rectangular wave guide, TE and TM modes of propagation (Illustration in TE10 and TE11 modes)

Unit 4:

Radar system and Antenna: Radar block diagram and operation. Derivation of radar range equation, Basic antenna principle , Field and power radiated by a quarter wave grounded monopole and half wave dipole, concept of radiation resistance, theory of uniform linear array broad side and end fire arrays.

Ionosphere: General feature of ionosphere, effect of ionosphere on radio waves, Chapmans theory of ionosphere, Appleton Hartree theory of wave propagation through ionosphere.

Unit 5:

Optoelectronics and Fibre optics: LED and laser diodes, Basic constituent of optical communication system, Electromagnetic theory of propagation of light in optical fibre.

Books Recommended:

Microelectronics by Jacob Millman
Microwaves by K L Gupta
Advanced electronics and communicatin system by Wayne Tomasi
Optical electronics by A. Ghatak and K. Thyagrajan
Besides, books on general Electronics

OR,

COURSE CODE: 1Y2PHY403

(ELECTIVE) PAPER II

CONDENSED MATTER PHYSICS - II

Unit 1:

Many electron theory, Determinants as wavefunction, Heitler London and molecular orbital method, Hydrogen molecule, Hartree and Hartree- Fock approximations, Exchange and correlation energies.

Unit 2:

Weiss theory of ferromagnetism, Heisenberg model and molecular field theory, Spin waves and magnons, Curie- Weiss law for susceptibility, Ferri and antiferro-magnetic order, Domains and Bloch-wall energy

Unit 3:

Superconductivity : occurrence, type I and II superconductors, isotope effect, Meissner effect, Microwave and infra red properties, Thermodynamics of superconducting transitions, London's equations, Coherence length, Elements of BCS theory, tunneling, Josephson effect.

Unit 4:

Electron confinement in infinitely deep square well, confinement in two and one dimensional well, idea of quantum well structure, Quantum dots and wires.

Determination of particle size, increase in width of XRD peaks of nano particles, variation in Raman spectra of nano materials.

Different methods of preparation of nano-materials, Bottom up: cluster beams evaporation, ion beam deposition.

Unit 5:

Structure and symmetries of liquids, Liquid crystals and amorphous solids, Aperiodic solids and quasicrystals; Fibonaccy sequence, Penrose lattices and their extension to 3- dimensions.

Books Recommended:

Many body physics by G Mahan
Quantum theory of solids by Kittel
Thin films: Heavens
Physics of thin films: Chopra
Besides, books on general Condensed Matter Physics.

OR,

COURSE CODE: 1Y2PHY403

(ELECTIVE) PAPER II

ADVANCED QUANTUM MECHANICS - II

Unit 1:

Quantization of fields (second quantization), Quantization of real scalar field, Complex scalar field, Schrodinger field, Dirac field and electromagnetic radiation field, Interacting fields and Feynman diagrams, Time evolution of quantum system, propagators and Green's functions, Interaction picture, S-matrix, Lippman-Schwinger equation.

Unit 2:

Continuous and discrete transformations, Group structure, Proper and improper Lorentz transformations, SL (2C) representations, Poincare group.

Unit 3:

Real and complex scalar fields, Dirac field, electromagnetic field

Unit 4:

Interaction picture ,Covariant perturbation theory, S- matrix, Wick's theorem, Feynman diagrams.

Unit 5:

Feynman rules, Example of actual calculations: Rutherford, Bhabha, Moeller, Compton, $e^+ e^- \rightarrow \mu + \mu -$. Decay and scattering kinematics, Mandelstam variables and use of crossing symmetry.

Books recommended:

Relativistic quantum fields by Bjorken and Drell
Advanced quantum mechanics by Sakurai
Particle physics and introduction to field theory by Lee
Mesons and fields by Schweber, Bethe and Hoffmann
A first book of quantum field theory: A. Lahiri and
P.B.Pal Besides, books on general Quantum Mechanics

ELECTIVE COURSE PRACTICAL

COURSE CODE : 1Y2PHY404P

Electronics

Experiments:

1. Characteristics of a FET/MOSFET
2. Verification of truth tables of DeMoiver's theorem
3. Series/Parallel resonance
4. Filter circuits
5. Experiments with OP-Amplifiers
6. Experiments on digital electronics
7. Amplitude modulation and demodulation
8. Study of frequency modulation
9. Experiments on microprocessor(8085)
10. Design and study of DAC/ADC.

OR,

Condensed Matter Physics

Experiments:

1. Hall coefficients of a semi conductor
2. Energy band gap measurement by Four probe method
3. Quinke's method of susceptibility determination
4. Mono atomic/Di atomic chain of atoms – modes of vibration
5. Study of photo conductivity of a semiconductor
6. Characteristics of n-p-n/ p-n-p junction transistor in common base/emitter configurations
7. Determination of dielectric constant of a material

OR,

Advanced Quantum Mechanics

Experiments:

1. Determination of scattering cross section in Born's approximation.
2. Determination of binding energy in a square well potential.
3. Binding energy of a deuteron in a square well potential
4. Problems based on uncertainty relations
5. Determination of different parameters in n-p/p-p scattering problem.