Syllabus

OF

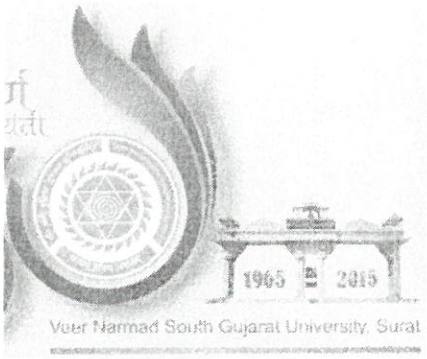
Course Work

for

MASTER OF SCIENCE (M.Sc.)

PHYSICS

Choice Based Credit System (CBCS)



DEPARTMENT OF PHYSICS,
VEER NARMAD SOUTH GUJARAT UNIVERSITY,
UDHANA MAGDALLA ROAD,
SURAT -395007. (GUJARAT)

Structure for M.Sc. Syllabus

Effective from June 2018

SEMESTER- IV

M.Sc. (PHYSICS)

Sr. No.	Course Code	Course Title	L	T	Cr.
	PH-541	Physics of Lasers & Lasers Applications	4	1	4
	PH-542	Atomic and Molecular Physics	4	1	4
	PH-(E)-543	Micro Electronics	4	1	4
	PH-(E)-544	Electronic Communication	4	1	4
	PH-(M)-543	Properties of Materials	4	1	4
	PH-(M)-544	Techniques of MaterialsScience	4	1	4
	PH-(T)-543	Advanced Quantum Mechanics	4	1	4
	PH-(T)-544	Group Theory and Quantum Field Theory	4	1	4
	PH-(N)-543	Nucleon-Nucleon Interaction and Nuclear Models	4	1	4
	PH-(N)-544	Strong, Weak and Electro Magnetic Interaction and QCD and Quark-Gluon Plasma	4	1	4
	PH-(C)-545	Practicals (Common)	9	1	8
	PH-(E)-545	Project (Electronics)	9	1	8
	PH-(M)-545	Project (Materials Science)	9	1	8
	PH-(T)-545	Project (Theoretical Physics)	9	1	8
	PH-(N)-545	Project (Nuclear Physics)	9	1	8
			25	05	24

Faculty Code: **Science** **Subject Code: PH** Level Code: **05**

Name of Program: **M.Sc.** Subject: **PHYSICS**

External Examination Time Duration: **03 Hours**

Name of Exam	Semester	PAPER No.	Course Group	Credit	Internal Marks	External Marks	Total Marks
M.Sc.	4	PH-541	Core	04	30	70	100
		PH-542	Core	04	30	70	100
		PH-543	Elective	04	30	70	100
		PH-544	Elective	04	30	70	100
		PH-545	Practicals and Project	08	60	140	200

DEPARTMENT OF PHYSICS, VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT -395007

M. Sc. (Physics): Semester-IV

PH- 541: Physics of Lasers and Lasers Applications

Unit 1 Laser : Introduction, Einstein coefficients, Population inversion, Methods of population inversion, Threshold conditions, Laser rate equations: Two, three & four level systems, Variation of Laser power around threshold, Optimum output coupling.

Unit 2 Optical Resonators: Modes of a rectangular cavity & open planar resonator, Quality factor, Ultimate line width of the laser, Transverse & longitudinal mode selection, Q- switching, Techniques & for Q- switching, Mode locking in lasers, Techniques for mode locking.

Unit 3 Properties of laser beams & types of lasers: Coherence properties of laser light, Temporal Coherence, Spatial Coherence, Directionality, Ruby laser, Neodymium lasers (Nd: YAG & Nd: Glass) He- Ne laser, CO_2 laser, Argon ion laser, Dye laser, Semiconductor lasers.

Unit 4 Non-linear optics: Introduction, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, Parametric generation light, self focusing of light, Multiphoton process: Multiquantum Photoelectric effect, Two photon processes, Theory of two photon processes, Experiments in two photon processes, Three photon processes, SHG & parametric generation of light in three photon process, Parametric light oscillator, Frequency up conversion, Phase conjugate optics.

Unit 5 Laser Spectroscopy: Rayleigh & Raman scattering, Stimulated Raman effect, Hyper- Raman effect Classical &Quantum mechanical treatment, Coherent anti stokes Raman Scattering, Spin Flip Raman laser, Free- electron laser, photo-acoustic Raman spectroscopy, Brillouin Scattering, Saturation Absorption spectroscopy, Doppler free two photon spectroscopy.

Unit 6 Applications of LASER: Modulation Methods, Communications, Applications Using Focused Laser Radiation, Medical applications, Coherent Light Image And Data Processing, Holography, Photorefractive Holographic Recording, Laser For Fusion, Laser Cooling, Integrated Optics, Quantum Interference and Lasing Without Inversion.

Recommended Books:

1. Optical Electronics: A. K. Ghatak & K. Thyagarajan
   (Cambridge university press, 1990)
2. Lasers & Non – linear optics : B.B.Laud
   (Wiley Eastern Limited)
3. Introduction to Fiber Optics : Ajay Ghatak & K. Thyagarajan
   (Cambridge university press,1999)
4. Principal's of Lasers : Orazio svelto & David C. Hanna
   (Plenum Press- New York and London)
5. Lasers and non linear optics: G. D. Baruha
   (Pragati Prakadhan)

Theory Tutorial

PH- 541: Physics of Laser and Lasers Applications

(Discussion and problem solving/exercise sessions)

1. Applications of laser in pure & applied sciences.
2. Chemical lasers
3. Non- liners effects in Fibers
4. Kerr effect
5. Fourier transforms & Optical application
6. Coherence & stellar interferometry.
7. Components of a lightwave communication system:Optical fiber
8. Modulators & Dectectors of a lightwave communication system.

M.Sc. (Physics): Semester-IV

PH-542 : Atomic and Molecular Physics

Unit 1 **One electron Atoms**

One-electron atoms, The Schrödinger equation and its solution, energy-levels and Eigen- -Functions, special hydrogenic systems, interaction of one-electron atoms with electromagnetic radiation, the dipole selection rules. Einstein coefficients, selection rules, Fine structure of hydrogenic atoms The Lamb shift and itsdetermination, Hyperfine structure and isotopic shifts, The Stark effect, The Zeeman effect in strong and weak fields

Unit 2 **Two-electron atoms**

Schrödinger equation for Two-electron atoms - the role of Pauli exclusion principle, Energy levels of He atom. Level Scheme of two-electron atom, independent particle model, ground and excited states

Unit 3 **Many electron atoms**

The central field Approximation, The Thomas-Fermi model, The Hatree-fock method, Correction to the central field approximation, correlation effects , L-S coupling and j-j coupling. Many electron atom in an electromagnetic field, Selection rules for electric dipole transition, Retardation effects, magnetic dipole, electric quadrupole transitions

Unit 4 **Molecular Structure**

Born-Oppenheimer approximation - rotational, vibrational and electronics energy levels of dyatomic molecules, The electronic spin and Hund's cases, the structure of polyatomic molecules.

Unit 5 **Molecular Spectra**

Molecular spectra, Rotational spectra, vibrational-rotational and electronic spectra of diatomic molecules, Spin –dependent interaction and electric dipole transition, The Nuclear spin, The inverse spectrum of Ammonia

Unit 6 **Applications**

Magnetic resonance, Atom optics, Atoms in cavities and ions in traps, atomic clocks

M.Sc. Physics Semester-IV

NUCLEAR PHYSICS – III (NUCLEAR REACTIONS AND REACTOR PHYSICS)

UNIT I : Nuclear Reactions I

Types of Nuclear Reactions and conservation laws, Energetics of Nuclear Reactions, Isospin, Reaction Cross sections, Experimental Techniques, Coulomb Scattering, Nuclear Scattering, Scattering and Reaction cross sections.

UNIT-II : Nuclear Reactions II:

Ghoshal experiment, Compound nucleus reactions, Resonance Reactions, Direct reaction, Heavy-Ion Reactions, Super heavy elements, Pre-equilibrium reaction mechanism, Complete and incomplete fusion reactions, Optical Model.

Unit- III: Fission and Fusion

Discovery of Nuclear Fission, Characteristics of Fission, Energy release in fission, Emission of neutrons in fission fragments, Cross section of neutron induced fission, Nuclear Fusion, Thermo nuclear Reaction, Source of Energy in Stars, Nucleo-Synthesis.

UNIT – IV: Neutron Physics

Neutron Sources, Classification of Neutrons, Absorption and moderation of Neutrons, Neutron reactions and cross sections, Neutron Cappture, Interference and detection with neutrons.

UNIT – V: Particle Accelerators

Acceleration of charged particles, Van de Graaff accelerator, Tandem accelerators, Linear accelerators, Cyclotron, Synchrocyclotron and their applications.

UNIT – VI: Reactors

Thermal neutron diffusion and diffusion equation, Fast neutron diffusion and Fermi age equation, Nuclear Chain Reaction, Critical size of reactor, critical size of reactors of different shapes, Nuclear reactor, Classification of reactors, Physical process in reactors, Nuclear fuel conversion, Nuclear materials employed in reactors, Nuclear power.

Books:

Nuclear Physics by S. N. Ghosal
Introductory Nuclear Physics – K. S. Krane (Wiley India, 1988)
Nuclear Physics by D.C. Tayal (Himalaya Publishing House 2017)
Fundamentals of Nuclear Physics by Jahan Singh (A Pragati Publication 2012)
Nuclear Physics by R.D.Evans
Nuclear Physics – Roy & Nigam (Wiley Eastern Ltd. 1979)
Techniques for Nuclear and Particle Physics Experiments by W. R. Leo.
Experimental Nuclear Physics by R. M. Singru.

M.Sc. Physics Semester-IV
NUCLEAR PHYSICS- IV (HIGH ENERGY PHYSICS)

UNIT-I : Classification of Elementary Particles
Classification of elementary Particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.), Conservation laws and symmetry, Intrinsic parity, parity conservation in strong and electromagnetic interactions.

UNIT-II :Parity Violation
Quark model, baryons and mesons, C, P, and T invariance, Application of symmetry arguments to particle reactions, Parity non-conservation in weak interaction, Relativistic kinematics.

UNIT-III : The Eightfold Way
Introduction to unitary groups, generators, Casimir Invariants, Fundamental and adjoint representations, root and weight diagrams, meson and baryon octets, Gell-Mann-Nishijima Formula.

UNIT-IV: Quark Model
Product representations and irreps, symmetry group, Young Tableaux, quark model, meson and baryon wavefunctions.

UNIT-VI: Deep Inelastic Scattering
Elastic scattering off a point particle, form factors, Resenbluth formula, Breit frame, inelastic scattering, structure functions, dimensionless variables.

UNIT-VI:Parton Model
Bjorken Scaling, Parton model, Structure functions in terms of PDFs, Callan-Gross relation, kinematic regions, valence and sea quarks, gluons.

Books:
Introductory Nuclear Physics – K. S. Krane (Wiley India, 1988)
Nuclear Physics by D.C. Tayal (Himalaya Publishing House 2017)
Nuclear and Particle Physics – Burcham &Jobes (Addison Wesley, 1995)
Introduction to Elementary Particles, David Griffith, John Wiley and sons
Introduction to High Energy Physics – D.H. Perkins (Cambridge Univ. Press, 4th Ed.)
Quarks and leptons – Halzen& Martin (John Wiley & Sons, 1984)
Nuclear Physics in a Nutshell - Carlos A. Bertulani, Princeton Univ. Press

M. Sc. (Physics): Semester-IV

(Specialization : Nuclear Physics)

PH(N)-545 Practical

Note:

Practical consist of experiments in two groups **A** and **B**.

Group **A** experiments are common for all the specialization.

Group **B** Project work in their subject of specialization (based on syllabus).

Group A: List of Experiment **(3 hours/ week + 1 hour/week tutorial)**

C-Programming Exercises:

1. Writing and testing C-programs for Interpolation and inverse interpolation using Lagrange's formula.
2. Writing and testing C-programs for Numerical integration using Simpson's $1/3^{rd}$ rule.
3. Writing and testing C-programs for solving ordinary differential equations.

Nuclear Physics Experiments:

4. Determination of plateau for Geiger-Müller tube and radiation absorption coefficient of a material.
5. Gamma ray spectrometer: calibration and finding gamma ray energy of a source.
6. Rutherford Scattering experiment.

Laboratory Tutorial

- Discussion of techniques of actual numerical computation, program writing concepts, error analysis to supplement actual exercise given for numerical analysis and computer programming.
- Construction and working of GM tube detector
- Principles behind gamma ray spectrometer.
- Alpha radioactive sources and detectors.

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SURAT