Preamble
M.Sc. Physics

Physics is the most of basic of sciences. It seeks to understand natural phenomena in a quantitative manner, and to answer some of the oldest and deepest questions ever asked by human beings: What are things made of? Is there a limit to the smallest things that we can think of? Did the world have a beginning? Will it have an end? At the same time, it provides the base of much of the technology that we take for granted in the 21^{st} century: computers, artificial satellites, mobile phones, TV, microwave ovens… Indeed, it will not be an exaggeration to say that modern human life is shaped by technologies that are largely based on a foundation of physics.

Physics as a discipline has existed for three hundred years and has a large 'core' body of knowledge. Our M.Sc. programme lays emphasis on the courses that constitute this core component, while providing students with a bouquet of optional papers covering almost all branches of physics. Those who wish to pursue higher studies in the subject are thereby well equipped to choose their branch of study. The programme also aims at equipping future teachers (at college as well school level) with a thorough grounding in the subject. Since physics is the base of much of modern technology, the programme also gives adequate hands-on experience to students who may go on to work in applied fields. Finally, viewing physics as a training ground for the mind the programme also aims to equip those who go into other fields of work with logical thinking and a critical attitude.

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Programme specific outcome: M.Sc. Physics

- Understanding the basic concepts of physics particularly concepts in classical mechanics, quantum mechanics, statistical mechanics and electricity and magnetism to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.
- Learn to carry out experiments in basic as well as certain advanced areas of physics such as nuclear physics, condensed matter physics, nanoscience, lasers and electronics.
- Understand the basic concepts of certain sub fields such as nuclear and high energy physics, atomic and molecular physics, solid state physics, plasma physics, astrophysics, general theory of relativity, nonlinear dynamics and complex system.

- Gain hands on experience to work in applied fields.
- Gain a through grounding in the subject to be able to teach it at college as well as school lever.
- Viewing physics as a training ground for the mind developing a critical attitude and the faculty of logical reasoning that can be applied to diverse fields.

Course specific outcome: M.Sc. elective courses:

COURSE OUTCOME		
Sr. No.	**Course Code and Name**	
1.	PHYS 511 Physics at Nanoscale-I (Theory Course)	• Introduction to the physics of materials and solid in the nanoscale range • The variation of the properties of solid in terms of band gaps, electronic in nanoscale • Imaging nanoscale structure using electron microscopy and the theory
2.	PHYS 512 & 532 Nanoscience Lab.-I & II (Lab. Course)	• Trained to prepare some nanoparticle by chemical and physical process • Characterization of the prepared nanoparticles for structural and optical properties • They are trained to handle several high end apparatus
3.	PHYS 531 Physics at Nanoscale-II(Theory Course)	• Methods of preparing nanostructure using chemical and physical process • Structural and chemical characterization of nano structure • Application based on semiconductor devices using single e devices.
4.	PHYS 513 Electronics-I (Theory Course)	• Signal and noise measurement considerations in electronics and communications • Electromagnetic wave propagation in guided media and unguided media. • Digital signal processing methods in discrete time domain and frequency domain. • Design of digital filters, Structures of finite and infinite impulse response

		filters.
5.	PHYS 514 Electronics Lab.-I (Lab. Course)	• Design, development and testing of electronic circuits with OP amps, discrete electronic components and integrated circuit chips. • Designing amplifier, oscillator, and wave shaping circuits for defined specifications. • Designing electronic filters and understanding phase sensitive lock-in detection technique. • Understanding micro-controller programming for software driven electronic circuits.
	PHYS 534 Electronics Lab.- II (Lab. Course)	• Developing skills of presenting work in written form as well as oral presentation. Working in a group, inculcating tem spirit and promoting pear learning. • Interfacing electronics circuits the outside world. • Leaning to use transducers and sensor in practical circuits • Developing automated measurement techniques • Developing smart technology(Robotics)
6.	PHYS 533 Electronics-II (Theory Course)	• Physics of semiconductor devices with semiconductor junctions, metal-semiconductor and metal-oxide semiconductor contacts. • Design considerations and performance of semiconductor devices for high frequency microwave applications. • Semiconductor photonic devices and quantum well hetero-structures for detection and production of optical radiation. • Optical, magnetic and semiconductor based memory storage devices. Functioning of advanced piezoelectric and magnetic transducers
7.	PHYS 515 Solid State Physics-I (Theory	• Introducing basic concepts via structural properties of materials • Understanding the basic transport

	Course)	properties of metals and semiconductors • Their introduction to the band structures for studying different materials
	PHYS 535 Solid State Physics-II (Theory Course)	• This course is more on the application of theory taught in part-I • Introducing the behavior of ferroelectric and ferromagnetic material in terms of their properties and applications • The basic theory of Quantum all effects and the application for standardizing resistance
8.	PHYS 516 & 536 Solid State Lab.-I & II (Lab. Course)	• Experiments to study metal and semiconductors in lieu with the theory taught in class • Small projects in association with the research students to introduce some research based experiments like optical propot materials, ferroelectric, band structure • They are trained to work in a group and also learn to preset their ideas
9.	PHYS 517 Nuclear Physics-I (Theory Course)	• Understanding the theory behind nuclear experimental technologies to identify particles and radiation • Understanding the principles of accelerators beam optics, vacuum technology, nuclear electronics, digital pulse processing, data acquisition and detector technology. • Understanding the applications of nuclear techniques in various fields.
10.	PHYS 537 Nuclear Physics-II (Theory Course)	• Understanding the structure of nuclei through nuclear models. • Understanding nuclear reaction dynamics and its mechanism. • Understanding challenges in modern nuclear physics including, exotic nuclei and their production. • Understanding aspects of nuclear astrophysics including nuclear reactions and energy production in stars.
11.	PHYS 518 & 538 Nuclear Physics-I & II (Lab. Course)	• Practical knowledge of radiation sources. • Ability to practically identify various types of particles and radiations

		using different detectors. • Experimental skill development by performing basic practicals on γ, β radiation. • Hands on experience with nuclear electronics including data acquisition and data processing.
12.	PHYS 519 Laser & Spectroscopy-I (Theory course)	• Understanding the polyatomic molecules by their topological symmetry and assigning of their point groups • Understanding the relations and connections between vibrational spectra.(such as IR and Raman) and symmetry of polyatomic molecules along with their electronic structure. • Understanding more about various lasers, tunability and their production techniques along with various spectroscopic methods based on laser as a source.
13.	PHYS 539 Laser & Spectroscopy-II (Theory course)	• Understanding further some more laser spectroscopic techniques and laser cooling • Understanding various other spectroscopies such as NMR, ESR or EPR, Mossbauer and XPS • Understanding these various other spectroscopic techniques for appropriately analysing various material properties.
14.	PHYS 520 Laser & Spectroscopy Lab.-I (Lab. Course)	• Practical knowledge of various spectroscopic methods such as IR, Raman, Flourescence, Ellipsometry, UV/Vis etc • Ability to analyse various spectra and identify the molecules by their spectra. • Experimental skill development by performing basic spectroscoic measurements
15.	PHYS 540 Laser & Spectroscopy Lab.-II (Lab. Course)	• Practical knowledge of various measurement methods using lasers and optical fibers. • Ability to set up experiments like holography using lasers. • Experimental and analytical skill development by performing various experiments on the same molecules or material.

		• Understanding the connection to theory and experimental spectroscopy.
16.	PHYS 551 Particle Physics-I	• Relativistic dynamics, esp. in the context of multiparticle interactions. • The role of symmetries, both discrete and continuous in understanding particle interactions and their classification. SU(3) and quark model. • Based on observables, drawing up a theory of particle interactions. Fermi theory of beta decay.
17.	PHYS 571 Particle Physics-II	• CVC and PCAC as tools to understanding weak interactions. Intermediate Vector bosons. Formulation of the electroweak theory, including the Higgs mechanism. • Phenomenological understanding of meson mixing and CP violation. Microscopic derivation within the Standard Model • Unraveling the structure of proton through high-energy electron-proton scattering. QCD.
18.	PHYS 552 Field Theory & QED-I	• Quantizing free fields (both canonical quantization and path integral approach). Fermions as representations of the symmetry group. n-point correlations. • Interacting fields; Wick contractions; Feynman rules • Calculating simple processes (both scalar theory and QED)
19.	PHYS 572 Field Theory & QED-II	• Loops. Regularization and renormalization. • Gauge theories (QED and nonabelian). Ward and Slavnov-Taylor identities. • beta-functions • Tests of QFTs (anomalous magnetic moments, Lamb shift etc)
20.	PHYS 553 Adv. Solid State Theory-I	• Understanding the lattice vibrations of a three-dimensional polyatomic vibrating crystal. • Understanding of atomic and nuclear resonance fluorescence and its applications.

		• Understanding various shifts and splits in the energy levels viz., Gravitational Red Shift, Isomer shift, Second order Doppler shift, Quadrupole splitting and magnetic splitting. • Understanding of thermal neutron scattering and dynamical structure factor for crystal, gas and a simple liquid. • Introduction of Green's function, its Fourier transform and their relationships to density of states.
21.	PHYS 573 Adv. Solid State Theory-II	• Quantum mechanical illustration of the diamagnetic, paramagnetic, ferro and antiferro-magnetic properties of solids • Meticulous aspects of spin waves or magnons using second quantization • Rigorous study of various theoretical treatments of superconductivity, including BCS theory • Understanding the Josephson junction effects and their applications • Critical understanding of Integral and Fractional Quantum Hall effects • Introduction to other special topics such as Bose Einstein condensation, Fermi liquid etc.
22.	PHYS 554 Plasma Physics-I	• Understanding the plasma state as distinct from other three states, developing concepts of Debye screening collective behavior, quasi neutrality. • Deriving a set of fluid equations to study plasma properties • Using fluid equations to study plasma waves, equilibrium and stability • Understanding concepts of plasma resistivity, diamagnetism, paramagnetism •
23.	PHYS 574 Plasma Physics-II	• Developing Kinetic description of hot plasma • Understanding waves and instabilities in hot plasma. • Understanding equilibrium and stability of fusion plasma, magnetic

		confinement and inertial confinement schemes, Tokamaks, laser fusion, • Applications of plasma, plasma based particle accelerators, plasma processing, industrial plasmas.
24.	PHYS 555 Astronomy & Astrophysics-I	• Understanding the basic quantities used in astronomy viz. coordinates, magnitude, mass etc. • Familiarity with measurement techniques of these quantities as well as classification of stars. • Understanding the workings of measuring instruments as well as their use. • Understanding of the Sun and solar phenomena like sun spots, flares etc. • Knowledge of various types of variable stars and their use in astronomy.
25.	PHYS 575 Astronomy & Astrophysics-II	• Understanding the Physics of stellar evolution • Understanding radiative transfer in stars • Solving Lane-Emden equation for polytropes • Understanding the physics of white dwarfs and neutron starts. Elementary knowledge of pulsars • Understanding the basics of cosmology and the dynamics of an expanding universe
26.	PHYS 556 GTR & Cosmology-I	• Understanding the Equivalence Principle & general covariance and its importance. • Understanding tensors and being familiar with tensor manipulations. • Understanding Einstein's equation and its consequences. Knowledge of Schwarzschild solution and singularities. • Understanding the classical tests of General theory of relativity • Knowledge of energy momentum in gravity and action principle for field equations.
27.	PHYS 576	• Familiarity with solutions of Einstein's equations in particular

	GTR & Cosmology-II	cases. Knowledge of TOV equation & polytropes. • Knowledge of compact objects like White dwarfs and neutron stars and the stability of super massive objects • Understanding the basis of standard cosmology. Knowledge of the FRW metric using it to understand cosmology • Knowledge of the history of the universe including Big Bang Nucleosynthesis and Cosmic Microwave Background • Understanding gravitational waves as a consequence of Einstein's equations. Knowledge of the physics of gravitational waves and its detection
28.	PHYS 557 Mathematical Physics	• Groups and representations : the mathematical aspects • Characterise discrete symmetries as in solid state systems; Lie groups and their usages in quantum mechanics, relativity, generic Hamiltonian systems, quantum field theories etc. • Integral equations and boundary value problems; usage in solving for physical systems.
29.	PHYS 558 Complex Systems and Networ	• Undertaking that large networks interacting of non-identical components underline all biological and social systems and provide a glimpse into their complexity. • Using the methods of graph theory to characterize the structure of complex network. • Using dynamical systems theory method to understand processes on networks with applications in physical, biological and social sciences. • Understanding the evolution of complex systems from the perspective of the dynamics by networks.
29.	PHYS 577	• Technical method of dynamics of application to Nonlinear systems of many fields.

	Non-linear Dynamics	• Understanding of Solitonic solution (useful in fiber optics). • Knowledge of non-linear time series analysis for understanding the experimental data.
30.	PHYS 578 Introduction to String Theory	• The particle physics reasons behind the string paradigm. The problem and the reinterpretation as a possible theory of gravitation. Problems with quantization of the Einstein theory. • Fundamental string as a generalization of the point-particle. Nambu-Goto and Polyakov actions. Quantization. Light cone gauge. Symmetry structures. • Theories in higher dimensions. Compactification and Kaluza-Klein reductions. • Some advanced topics (the instructor selects some) (i) Conformal Field Theories. (ii) Scattering amplitudes and Vertex operators. (iii) Fermions in non-flat backgrounds. (iv) World sheet super-symmetry. (v) Extended structures as solutions. D- branes. (vi) Dualities. (vii) Strings in a non-flat background.
31.	PHYS 579 Observational Astronomy Lab.	• Practical knowledge of handling telescopes and instruments like CCD cameras for observations) • Ability to practically take data for various astronomical sources) • Skill development of data analysis utilizing various software as well as astro-statistics) • Human resource development for mega projects in astronomy like the TMT, LIGO and SKA)
32.	PHYS 580	• Random numbers generators, Monte Carlo methods and statistical distribution.

	Adv. Numerical Techniques	• Curve fitting and parameter estimation • Interpolation, differentiation, and integration • Simultaneous linear equations, matrix inversion, matrix eigenvalues and diagonalization. • Higher order differential equations and partial differential equations