MAHISHADAL RAJ COLLEGE
DEPARTMENT OF PHYSICS

PROGRAM SPECIFIC OUTCOMES (PSO) and COURSE OUTCOMES (CO): PSO & CO

Name of the Program: M.Sc. Physics (CBCS) under Vidyasagar University

Year of introduction: 2018

Program Specific Outcomes (PSO):

M.Sc. Physics (under CBCS curriculum of the Vidyasagar University)

M.Sc Physics programme is based on total syllabus covering almost all the fields of Physics. The syllabus is based on CBCS and the students get good knowledge after completing the course. Thus in every year a significant number of students qualify national level examination like NET, GATE, SET, JEST. The programme design will ensure that students passing out will have completed the standard pre-requisites for them to take up doctoral programme in India and abroad. The multidisciplinary and interdisciplinary skills which they have acquired will be of tremendous value to them especially if they choose to enter such research areas as nano-scale physics, theoretical as well as experimental Solid State Physics, Optoelectronics, and Electronics.

Course Outcomes (CO):

Semester-I

PHS 101.1: Methods of Mathematical Physics

At the end of the course students will be able to,

1. Identify a range of mathematical methods that are essential for solving advanced problems in theoretical physics, interpret and illustrate the interactions between mathematics and the associated field and demonstrate the ability to apply mathematical concepts and techniques in to problems in that field, elaborate the understanding of basic concept of complex variables.

2. The students should be able to formulate and express a physical law in terms of tensors, and simplify it by use of coordinate transforms.

3. Analyse the wide range of special functions and transformations of different series.

4. Describe various processes involved in understanding the behaviour of different systems through mathematics.

5. Implement mathematical skills to solve problems in advanced physics.

PHS 101.2: Classical Mechanics

In the era of modern physics, this course in classical mechanics remained absolutely essential in the way it is designed. Firstly this course acts as the stepping stone for the various branches of modern physics. e.g. the technique of action-angle variable is needed for older quantum mechanics, the Hamilton Jacobi formalism and the principle of least action paved the way to wave mechanics and the Poisson Bracket and canonical transformation leads to the justification of commutator formalisms and equation of motions. This course also provides an opportunity for students of physics to master many of the mathematical techniques.

PHS 102.1: Quantum Mechanics-I

At the end of the course students will be able to,

1. Identify and understand the kinds of experimental results which are incompatible with classical physics and which required the development of a quantum theory of matter and light.

2. Interpret the wave function and apply operators to it to obtain information about a particle's physical properties such as position, momentum and energy.

3. Solve the Schrodinger equation to obtain wave functions for some basic, physically important types of potential in one dimension, and estimate the shape of the wave function based on the shape of the potential, Hydrogen atom problem and Harmonic Oscillator problem.

4. To apply the technique of separation of variables to solve problems in more than one dimension and to understand the role of degeneracy in the occurrence of electron shell structure in atoms. The problems can be solved in different pictures to calculate correlation function used in applied science.

PHS 102.2: Solid State-1

The course gives good idea to students related to structure and symmetry of solid. The course also gives light to the structural analysis of the materials and introduce new particle phonon in solid. The course deals with Band Theory of Solid which is an important tool for material study and research.

PHS 103.1: Electrodynamics

The aims and objectives of the course on Electrodynamics are

1. To familiarize the students of M.Sc. class to know the fundamental concepts about plasma, the mechanism of radiation by free charges of plasma, and excited atoms and ions; and their current transport.

2. To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific methods.

3. To provide concepts of retarded phenomena and radiation by different material media and corresponding scattering dispersion relations.

4. The students will have an understanding the relativistic electrodynamics.

5. The students will be able to analyse radiation systems in which the electric dipole, magnetic dipole or electric quadruple dominate.

6. The students will have an understanding of the covariant formulation of electrodynamics and

the concept of retarded time for charges undergoing acceleration.

PHS 103.2: Materials: Preparation and Characterization

The course is typically a bridge between a physicist and a material scientist and the course is framed to enable students to understand the,

1. expanding world of functional materials,
2. state of the art facts and techniques involved in materials preparation,
3. comprehensive awareness of use of different instruments for material study,
4. development of the various aspects of material characterization,
5. use of different experimental techniques, challenges and prospects materials science.

PHS 104.1: Analog Electronics-I

At the end of the course, students will be able to,

1. impart basic knowledge on Analog and Digital Electronics.
2. clarify and exemplify the previous knowledge of electronics in B.Sc. courses.
3. learn the basics of Op-Amp circuits and Analog communication systems.
4. gain knowledge on Radar, Antenna and MOSFET circuits.

PHS 104.2: Digital Electronics-I

At the end of the course, students will be able to,

1. gain basic knowledge of application of Digital Logic gates.
2. learn the structure and use of flip flops, counters, registers etc.

PHS 195: Electronics Practical-I

With this course, students will be able to design and fabricate various digital and analog electronic circuits, e.g. Op-Amp amplifiers, oscillator circuits.

PHS 196: Computer Programming

The students will get good training in computer programming in this course. The programming knowledge will help them in Higher Study and Research.

Semester-II

PHS 201.1: QuantumMechanics-II

At the end of the course students will be able to

1. apply the postulates of Quantum Mechanics to rotational motion

2. use the commutation relations to understand the link between the angular momentum operator and the generator of rotations.

3. compute the eigen-systems of L^2 and L_z, the coefficients of the expansion of the angular part of
4. a wave function in terms of spherical harmonics.

5. find the matrix elements of the operators corresponding to the addition of angular momenta in both the uncoupled and the coupled basis.

6. understand the concept of spin, Pauli spin matrices, Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations.

7. calculate the Matrix elements for rotated state, irreducible tensor operator.

8. understand the application of non-relativistic Hamiltonian for an electron with spin included.

PHS 201.2: Methods of Mathematical Physics - II

At the end of the course, students will be able to

1. identify a range of mathematical methods that are essential for solving advanced problems in theoretical physics,

2. interpret and illustrate the interactions between mathematics and the associated field and demonstrate the ability to apply mathematical concepts and techniques in to problems in that field

3. elaborate the understanding of basic concept of Fourier and Laplace's transform.

4. understand the applications of group theory in all the branches of Physics problems.

5. use Fourier series and transformations as an aid for analyzing experimental data.

6. use integral transform to solve mathematical problems of interest in Physics.

7. develop mathematical skills to solve quantitative problems in physics.

PHS 202.1: Solid State II

This course is combined with the basic theory and phenomenology of superconductivity and dielectrics and their many applications in basic science and technology. The course on superconductivity includes the electrical and magnetic properties of superconductors, the thermodynamics of superconductors, the origin of quantized magnetic flux and the Josephson tunneling. The dielectrics course is devoted to the study of dielectric polarization and relaxation phenomena in condensed matter. Basic theory and different experimental techniques of dielectrics are given.

PHS 202.2: Semiconductor Physics

Students are enriched in semiconductor field by taking the course. Most modern devices are based on semiconductors. Hence it is important to know the basics of semiconductors. The students will hence understand the operation and mechanism of important semiconducting devices. The course will also motivate the students for research in the field of semiconductor physics.

PHS 203.1: Analog Electronics-II

After completion of this course, students will be able

1. to achieve the detail knowledge of network analysis.
2. to gain knowledge on transmission lines: its theory and application.
3. to understand the operation of different transducers like LED, Laser diode, photodetectors, solar cells, thermistor etc.
4. to gain knowledge on different combinational circuits like MUX, DeMUX, Encoder, Decoder etc.

PHS 203.2: Digital electronics-II

After completion of this course, students will be able

1. to understand the basic structure of 8085 microprocessor.
2. to learn the structure and use of different memory units.
3. to gain basic idea of digital communication.

C-PHS 204: Concepts of Physics: Inventions and applications (CBCS)

The course is offered to introduce the basic concepts of modern physics to the students coming from outside the Physics Department as a choice based subject. The course is aimed to offer the students to understand the important developments of physical Science, physics of Nature, electrical conductivity, electromagnetic wave, development of different light sources, applied optics, medical instrumentation and working principles of different instruments.

PHS 295: Electronics Practical-II

This course will help the students to design and fabricate various digital and analog electronic circuits, e.g. counters, multivibrators, oscillator circuits.

PHS 296: Advance Practical-I

This practical course structure is designed to impart the students to provide strong hands-on laboratory training in modern, currently active, areas of Physics particularly in optics, semiconductor physics and nuclear physics.

Semester-III

PHS 301.1: Quantum Mechanics-III

At the end of the course students will be able to,

1. provide an understanding of the formalism and language of non-relativistic quantum mechanics and various approximation methods.

2. to understand the concepts of time-independent perturbation theory and their applications to physical situations and quantum scattering theory which are applicable in nuclear and particle physics.

3. to formulate and solve problems in quantum mechanics using Dirac representation.

4. to grasp the concepts of spin and angular momentum, as well as their quantization and addition rules.

PHS 301.2: Statistical Mechanics – I

At the end of this course the students will be able,

1. to work out equations of state and thermodynamic potentials for elementary systems of particles.

2. to have an appreciation for the modern aspects of equilibrium and non-equilibrium statistical physics.

3. to describe the features and examples of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

4. to understand Equations of state and thermodynamic potentials for elementary systems of particles.

5. to describe the features and examples of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics.

6. to work with various models of phase transitions and thermodynamic fluctuations. Describe physical quantities in quantum systems.

PHS 302.1: Molecular Spectroscopy & Laser Physics

This course is combined with the basic theory and phenomenology of Laser Physics and provides an introduction to molecular spectroscopy. The course on laser physics provides an insight into the physical principles of operation of lasers, construction of laser, and their applications in different areas of science and industry. This course also covers different methods of Q-switching for the generation of ultra-short laser pulse. The course on molecular spectroscopy introduces the three key spectroscopic methods used by physicist, chemist and biochemist to analyse the molecular and electronic structure of atoms and molecules. These are Rotational, Vibrational and Electronic spectroscopy. Numerous exercises are provided to facilitate mastery of each topic.

PHS 302.2: Nuclear Physics-I

The aim and objective of the course on Nuclear Physics is to familiarize the students of M.Sc. class to the basic aspects of Nuclear Physics like static properties of nuclei and three radioactive decays. The main objectives of this course are to understand the basic properties of nucleus; to develop the understanding of nuclear properties and different nuclear spectroscopy. At the end of the course, students will be able to acquire basic knowledge about nuclear properties such as mass, spin, radius, binding energy and radioactive decay.

PHS 303A: Solid State Physics –I

The course topic is Solid State Physics special paper which covers large part in this field. The course enriches the student in many fields like defects in solid and introduces important new particles like Plasmon, Polariton, Polaron, Exciton. The course also includes Luminescence in solid and transport properties of metal. The course also describes the origin of Landau Levels. The course will motivate the students to do research in these fields both in Theoretical as well as Experimental Solid State physics.

C-PHS 304: Introductory Astrophysics (CBCS)

The course is arranged to introduce the basic concepts of astrophysics to the students coming from other than physics department as a choice based subject. The course is framed to enable students to understand the

1. Fundamental concept of Universe,
2. Stars, galaxy and other celestial objects,
3. Different parameters for astrophysical measurements,
4. details of Sun and solar system and related phenomena,
5. Evolution of universe and stars.

PHS 395: Advance Practical-II (Practical)

This practical course structure is designed to impart the students to provide strong hands on laboratory training in modern, currently active, areas of Physics particularly in optics, semiconductor physics and nuclear physics.

PHS 396A: Solid State Physics-I (Practical)

This practical course structure is designed to impart the students to provide strong hands on laboratory training especially in the advance field of Solid State Physics. This will help them immensely for research in condensed matter physics as well as experimental research in Solid State Physics.

Semester-IV

PHS 401.1: Particle Physics

The aim and objective of the course on Particle Physics is to introduce the M.Sc. students to the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective. At the end of the course, the student will be able to understand overview of particle spectrum, their interaction and major historical and latest developments, various invariance principles and symmetry properties in particle physics, basic rules of Feynman diagrams and the quark model for hadrons, properties of neutrons and protons in term.

PHS 401.2: Statistical Mechanics-II

At the end of the course, the student will be able to understand different quantum statistics for explanation of B.E. condensation, Black body radiations, Pauli paramagnetism, Landau diamagnetism and electron gas systems for thermionic and photoelectric emission; also to use and develop mean field theory for first and second order phase transitions in one and two dimensional Ising model.

PHS 402.1: Nuclear Physics-II

At the end of the course, students will be able to

1. understand the features of nuclear forces, exchange force and meson theory,
2. to develop the understanding of nucleon-nucleon interactions,
3. to develop the understanding of resonance reactions,
4. to understand the various nuclear models,
5. to understand the different nuclear reactions,
6. to clarify the concepts of elementary particles,
7. to learn about the concept of subatomic particle and quarks, conservation laws.

PHS 402.2: Quantum Field Theory

At the end of the course, students will be able to

1. understand Quantum field theory so that they can use these in various branches of physics as per their requirement,
2. understand relativistic effects in quantum mechanics and need for quantum field theory,
3. demonstrate the Lorentz covariant form of Lagrangian and Hamiltonian for scalar, vector fields, electromagnetic fields and their second quantisation,
4. understand the symmetries and the implications of Noether's Theorem in conserved currents and charges,
5. understand the interaction picture, S-matrix, and Wick's Theorem,
6. explain the origin of Feynman diagrams and apply the Feynman rules to derive the amplitudes for elementary processes in QED.

PHS 403.1: Semiconductor Devices

Most of the devices are based on semiconductors. The course discusses in details the various devices and their operation mechanism. The course describes extensively many important devices like Gunn Diode, FET, MOSFET and Semiconductor Laser. The course also includes important topic like Quantum Hall Effect, Thermoelectric effect in Semiconductors. The course will encourage the students to do researches in Semiconductor devices which is an important topic of Applied Physics.

PHS 403.2: Applied Optics

The course is an introduction to the fundamentals of optoelectronics and principles of the optoelectronic devices operation. This course helps students prepare them for advanced study and research in semiconductor optics and optoelectronic devices. Topics include optical waveguides, optical logic operations, nonlinear optics an introduction to different types of detectors, and holography. The course also covers the basic optical and electro-optical properties of semiconductors and low-dimensional semiconductor structures.

PHS 404A: Solid State Physics – II

The course topic is Solid State Physics special paper which covers large part in this field The course enriches the student in many field like Magnetism, Superconductivity which are two important branches of Physics. The course will motivate the students to do research in these fields both in Theoretical as well as Experimental Solid State physics.

PHS 495A: Solid State Physics -II (Practical)

This practical course structure is designed to impart the students to provide strong hands on laboratory training especially in the advance field of Solid State Physics. This will help them immensely for research in condensed matter physics as well as experimental research in Solid State Physics.

PHS 496: PROJECT, SEMINAR AND GRAND VIVA

A significant aspect of this particular curriculum is the opening that the students will have to perform a dissertation research project during their last two semesters on wide range of modern-day topics under the guidance of any of the faculty members of Physics department and the exam will be held at the end of fourth semester. This gives an ideal atmosphere for converting class room learning to cutting-edge research applications. Each student has to present a seminar in the final semester. There is a good interacting session in the seminar. Thus seminar gives a good training to student and gives encouragement to be a participant of National and International Seminars.