Programme Outcomes

1. To create, apply, and disseminate knowledge of physics in theoretical and experimental domains under different specializations.
2. To encourage creative thinking and problem-solving capabilities through tutorials.
3. To encourage research culture, provide research ambience and develop related technical proficiency.
4. To equip the students to use computers as a tool for scientific investigations/understanding.
5. Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behaviour, critical, interpersonal and communication skills as well as a commitment to life-long learning.

Programme Specific Outcomes

1. Student are able to apply the knowledge of core concepts of physics in semester exams, in the NET, SET and GATE, national level exams as well as in the research level projects work which is suitable to communicate/present further in workshops and conferences.
2. The students learn to carry out experiments in basic as well as certain advanced areas of physics such as lasers, spectroscopy, electronics, condensed matter physics, nanoscience.
3. The students gain hands-on experience to work in applied fields.
4. Through the research cultural of the department and skills acquired therein, students are capable of sustaining subsequent academic progression inside the country and overseas as well.
5. Regular practice of Self-declaration of the authenticity, uniqueness of project work, plagiarism check, and departmental scrutiny etc. inculcates the ethics in the research publication.

Veer Bahadur Singh Purvanchal University
Prof. Rajendra Singh (Rajju Bhaiya) Institute of Physical Sciences for Study and Research
Syllabus of M. Sc. Physics
Courses and their outcomes

Sr. No.	Course Title and Code	Course Outcomes After the completion of the course, student will be/able to
1.	Mathematical Physics (B0107U1T)	· Master of the basic elements of complex mathematical analysis · Derive Cauchy integral theorem and Cauchy integral formula and find Taylor and Laurent series expansion of functions of complex variable. · Understand the calculus of residue and evaluate some typical definite integral using the method of contour integration. · Solve differential equations that are common in physical sciences · Apply integral transforms to solve mathematical problems of interest in Physics · Students are able to understand and solve the problems based on special functions like Hermite, Bessel, Laguerre and Legendre functions. · Understanding how to use special functions in various physics problem · Students are able to understand fundamentals and applications of Fourier series, Fourier and Laplace transforms, their inverse transforms etc.
2.	Classical Mechanics (B0107U2T)	· Develop the skills to understand and use the Lagrangian and the Hamiltonian formalism for solving the equations of motion for any reasonable mechanical system. · Understand the Canonical Transformations. · Understand the Hamilton – Jacoby Theory. · Gain the familiarity with basic ideas of motion in small oscillations and normal modes.
3.	Electrodynamics and Relativity (B0107U3T)	· be familiar with the fundamental features and concepts of transmission lines and waveguides and their applications. · have basic understanding of tensor analysis. · be able to explain the fundamental concepts of geometry of space time in special relativity and the principle of causality. · have knowledge about Lorentz group and electromagnetic field tensor. · be able to perform Lorentz transformation of electric and magnetic fields. · be able to derive equation of motion of a charge particle and determine force on it when it being in static and uniform electric fields.

4.	Quantum Mechanics – I (B0107U4T)	· Gain knowledge of dimensionality of space and understanding the Dirac's notation used for physical state of a system. Representation of states, operators, and its finding probabilities in matrix form. · Learn the concept of quantum state measurement. Grasp the basic concept of uncertainty principle. · Develop a clear understanding of each class of representations. · Analyse the Harmonic Oscillator problem using Bra-Ket notation. · Learn the quantum mechanical algebra of angular momentum and calculation of Clebsch-Gordan coefficients.
5.	Fundamentals of Physics (B0107U8M)	· To appreciate Physics as a fundamental science and to understand the working of the Universe around us. · To develop a scientific temper.
6.	Quantum Mechanics – II (B0108U1T)	· understand the concept of perturbation and calculation for eigen value. · learn application of time – dependent perturbation theory for transition probability. · have basic understanding of non-relativistic quantum scattering. · be able to analyze the Klein-Gordon and explain problems arising while dealing with it. · be able to explain how Dirac addressed problems that occurred in the case of Klein Gordon equation. · be able to perform solutions of Klein-Gordan and Dirac equations for free particle.
7.	Statistical Mechanics (B0108U2T)	· Study the ensembles and its relation with different macroscopic quantities such as entropy, thermodynamic potentials, magnetization etc. · Compute the partition function and different thermodynamic quantities for quantum and classical systems. · Understand distribution functions of quantum ideal gases and to study the low temperature thermodynamic behaviour of quantum ideal gases, theory of liquid helium and superfluid. · Apply the degenerate ideal fermi gas model in conduction of electron in metals and to formulate random walk problem and to apply it to realistic systems in nature. · Gain knowledge on theory of non- equilibrium statistical mechanics and its application to different

		random process such as Brownian motion of colloidal particles with and without external forces. · Explain probability theory and its application to find the moments of the dynamical variables.
8.	Solid State Electronics (B0108U3T)	· Understand the fundamental designing and concepts of different types of Semiconductors, filters and regulators and characteristics of devices like PNP, and NPN etc. · Understand the working mechanism and circuit components of FETs and other circuit elements. · Understand the concept of feedback amplification and different class of negative feedback amplifiers. · Develop the understanding on power and radio frequency amplifiers and study on different circuit elements.
9.	Atomic and Molecular Physics (B0108U4T)	· Understand and explain the hydrogen and helium atomic spectrum · Recognize the spectroscopy of many electrons atomic systems and hyperfine splitting of spectral lines · Understand the rotational and vibrational spectra of diatomic molecule. · Understand the Raman spectra.
10.	General Lab. (B0107U5P/BU108U6P)	In this course the experiments are designed to give understanding of heat, magnetism, electricity and optics experiments. · By determining the velocity of ultrasonic waves in a liquid at different temperatures using Ultrasonic interferometer, students build understanding of Ultrasonics as a non-destructive testing tool for measuring mechanical and elastic properties of solid and liquid materials. · Optical Properties of Quartz experiment helps the students not only in understanding the behaviour of light passing through different axes of crystal but also in understanding birefringence and chirality of quartz crystal. · Determination of Stefan's constant by electrical method helps students to clarify the concept of black body radiation. · Fabry-Perot Interferometer and Edser-Butler fringes experiments make students aware of different optical interference techniques being used in the field of Physics. · Fresnel's Formula and Study of Total Internal Reflection experiments help the students to understand the refraction and reflection phenomena. · By Curie Temperature experiment and Quincke's tube method experiment, students learn about

		magnetic properties of materials. · Iodin Absorption spectra experiment helps students learn about absorption spectra and associated parameters and properties of Iodin and thus other materials.
11.	Electronics Lab. (B0107U6P/B0108U5P)	· The students learn to design and study the amplifiers in CB, CE and CC configurations. · The students gain knowledge on the variation of characteristics and constants of BJT, its Bias-stabilization and Band gap of semiconductor diodes. · The students are able to perform amplitude modulation and demodulation. · The students gain skills to design the Phase-Shift Oscillator, Tuned Collector Oscillator and Astable multivibrator. · The students learn the concept of Negative feedback.
12.	Frontiers of Physics (B0108U8M)	· To appreciate the emerging fields of research in Physics. · To address the vital topic of climate change and role of Physics in it. · To gain knowledge on applications of Physics in building sustainable future. · To develop a scientific temper and to contribute significantly in saving the environment.
13.	Solid State Physics (B0109U1T)	· Appreciate the need of band theory and figure out different types of band theory. Theory of semiconductors and fermi surface. · Grasp the concepts and basic ideas related to superconductivity and describe the · basic properties of Type I and Type II superconductors · Study of the ionic crystals in presence of infrared radiation. Conducting polymers. · Different type of lattice defects in solids and its application to generate colour centres, compute the number of vacancies in solids. · Explain the significance of different interactions and energies involved that explain the phenomena and properties of different types of magnetic materials. Classical and quantum theory of magnetic materials and its applications.
14.	Nuclear and Particle Physics (B0109U2T)	· have understanding of n-n, n-p and p-p scattering and charge symmetry of nuclear forces. · explain reasons behind ground state properties of nucleus such as spin-parity assignment, angular moment and magnetic moment with the help of shell model.

		· analyze kinematics formulation associated with different nuclear reactions including relativistic heavy ion reactions. · predict if an elementary particle reaction is allowed and to recognize the type of the interaction associated with it. · have fundamental understanding of nuclear decays and associated selection rules.
15.	Analog & Digital Electronics (B0109U3T)	· Learn about the frequency response curve of BJT and capacitor role in it. · Have descriptive knowledge of op-amp. Study the Ideal Characteristic of op-amp and its AC and DC characteristics. · Acquire an understanding for different applications of op-amp based on operations in linear analog system. · Gain an understanding for different applications of op-amp based on operations in non-linear analog system. · Understand the principle and application of different flip-flop. Types of registers and counters and its uses.
16.	Microwaves (B0109U4T)	· Explain different types of waveguides and their respective modes of propagation. · Explain working of microwave passive circuits such as isolator, circulator, Directional couplers, attenuators etc. · Describe working of microwave tubes and solid state devices. · Perform measurements on microwave devices and networks using power meter.
17.	Laser Spectroscopy (B0109U5T)	· Knowledge of various Light Sources (Arc, Spark, Discharge, Beam Foil etc.), Thermal and Direct Photo Detectors, Optical Multichannel Analyzer · To understand the basic laser fundamentals, unique properties of the laser, fixed frequency and tuneable lasers, high and low power lasers. · Learn principle and working of various lasers including gas, liquid and solid-state. · Know principle and working of semiconductor lasers and its type, p-n junction laser. · Learn about laser photoacoustic spectroscopy, laser induced fluorescence, Laser Raman Spectroscopy, Laser isotope separation, medical application of lasers

18.	Electronic Spectra of Diatomic Molecules (B0109U6T)	· Apply knowledge to detailed understanding of electronic spectra of diatomic molecule. · Understand the classification of molecular states. · Understand the continuous and diffuse spectra of diatomic molecule.
19.	Condensed Matter Physics-I (B0109U7T)	· Calculate the potential energy of solids by Ewald methods and Lorentz field. · Study of ab-intio theory of lattice dynamics for non-primitive lattice and theory of normal coordinates. · Quantization of lattice vibrations and optical properties of solids such as real and imaginary part of dielectric function. · Understanding of many body theory, basics of density functional theory and different type of exchange correlation functions such as LDA, GGA. Its application for calculation of electronic and optical properties of materials. · Different type of Martials and its characterization technique such as XRD, SEM, TEM, FTIR etc.
20.	Condensed Matter Physics-II (B0109U8T)	· Understand the dielectric and optical properties of ionic crystals. · Understand the basic concepts behind the different Raman scattering. · Learn the concept of Phonon, correlation functions and principle of causality. · Understand the role of defects in tailoring the optical and electrical properties of solids. · Execute the application of Green's function to explore the properties of solids.
21.	Experimental Techniques and Control Systems (B0110U1T	· Know elucidation and analysis of different experimental techniques used in laboratories. · Learn principle and working of some optoelectronic devices and detectors. · Have understanding of characteristics and applications of an operational amplifier. · Can explain different circuit and its methodology used for conversion of analog to digital or digital to analog data. · learn the basic concepts of microprocessor with some set of instructions used.
22.	Computational Physics with Python (B0110U2T)	· have fundamental understanding of different operating systems and working on Linux preferably Ubuntu. · have knowledge of different features of Python programming language including module, package and libraries. · can manage and manipulate data in different

		datafiles for desired calculations and draw 2D and 3D plots and graphs for data sets and functions. · be able to write computer programs for different numerical methods. · be able to perform numeric integration and differentiation using computer program. · can generate random numbers and solve waves equations including Schrödinger ’s equation using programming.
23.	Electrodynamics and Second Quantization (B0110U3T)	· Solution of inhomogeneous equation by Green function method. Advance and retarded green function. Analyse the Lienard-Wiechert Potential, calculate fields and power radiation due to moving charges. · Analysis and calculate the radiation from an accelerating charge and oscillating dipole. Calculation of electric and magnetic field of oscillating dipole. · Study of radiation force, radiation reaction and line width of an oscillator. · Covariant formulation of Lagrangian and its tensor form for energy, momentum and current density in four vector form. · Understanding of second quantization and its application in electromagnetic field. Problems on boson and fermion Creation and Annihilation.
24.	Group Theory (B0110U4T)	· understand the classification of finite groups. · Have basic mathematical concepts for working with group theory and also apply the knowledge of matrices for solving linear algebraic equations. · Analyse theorems in group theory and apply matrix representation of group for solving physics problems. · Learn about the role played by symmetries in studying classical and Quantum theories. · Learn basics of group theory and prepare group character tables for understanding crystallography.
25.	Microprocessor (B0110U5T),	· Gain introductory knowledge of microprocessor 8085 architecture and its operations. · Learn different set of instructions and ability to utilize in programming. · Can explain methodology for data transferring and basic idea of 8255. · Learn about memory and mapped based devices and instructions. · Can explain working of ADC 0809 and DAC 08 for data conversion.

26.	Physics of Semiconductor Devices (B0110U6T),	· knowledge of semiconductors · Knowledge of semiconductor carrier properties and statistics · Knowledge of semiconductor carrier action · Ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the PN-junction diode · Ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of Varactor Diode, Tunnel Diode, Gunn Diode · Ability to apply standard device models to explain/calculate critical internal parameters and standard characteristics of the Microwave Bipolar Junction Transistor
27.	Advanced Atomic Spectroscopy (B0110U7T)	· Learn about Lamb-shift in hydrogen atom, · Properties of complex spectra and their interpretation · Derivation of spectral term using Breit's scheme, Rydberg atoms · Know the limitations of optical microscopes · Learn about various microscopy techniques (SEM, TEM, AFM etc) · Basic idea of fluorescence microscopy
28.	IR & Raman Spectra of Polyatomic (B0110U8T)	· Able to describe group theory to classify the molecules and to recognize the symmetry of molecules. · Describe the detailed concept of Infrared and Raman spectra of Polyatomic molecules. · Understand selection rules to explain transitions. · Describe vibrational and rotational spectra of polyatomic molecule
29.	Condensed Matter Physics-III (B0110U9T)	· Gain the knowledge about the transport properties of solids and its application. · Understand a more elaborate view on lattice dynamics leading to plotting a determining phonon dispersion curve. · Understand the properties of semiconductors like thermal conductivity, specific heat capacities, electrical conductivity and their dependence temperature etc. · Understand the various types of magnetic phenomena like diamagnetism, para-magnetism, ferromagnetism, anti-ferromagnetism and ferrimagnetism exhibited by different solids. · Gain the knowledge about magnetic phase transitions, critical phenomena, Ising Model, ordered parameters and concept of magnons etc.

30.	Condensed Matter Physics-IV (B0110U10T)	· Basics of second quantization for fermions and its application for solving the Hamiltonian of Columbian interaction. · Generalized theory of dielectric function and its application for metals and plasma in high and low frequency limit. · Understanding of electron-phonon interaction and solving its Hamiltonian within external perturbation potentials. · Study of electron-electron interaction via phonon (BCS theory). Solution of second quantization form of interacting Hamiltonian by Bogoliubo- Valatin transformation. · Understanding of temperature dependent properties of superconductivity and flux quantization.
31.	Electronics Lab. (B0109U9P & B0110U11P)	· The students can perform mode analysis of klystron and characterization of directional coupler and Magic T and calibration of Attenuator. · The students are able to measure VSWR and complex dielectric constants of materials at microwave frequency and to verify the square law of crystal detector. · The students can explain steady state and transient response of wide band amplifier. · The students learn about A/D and D/A converter and perform conversion from Analog to Digital signal (and vis-versa).
32.	Laser and Spectroscopy Lab. (B0109U10P & B0110U12P)	· Study of Zeeman effect experiment enable students to determine the energy levels in atoms and identify them in terms of angular momenta. · The "Study of LIF spectra" and "Laser excited spectra" helps students learn about optical spectroscopic techniques where Laser induced fluorescence and excitation of the sample are used. · The students learn to measure the intensity of spectral lines and detect unknown elements by recoding emission spectra. · The students gain skills to study properties associated with absorption, reflectance, transmission and basic fluorescence of different samples using the Fibre Optic UV-Vis Spectrometer.
33.	Condensed Matter Physics Lab. (B0109U11P & B0110U13P)	· learn to measure the Lande-g factor of electron for standard ESR sample (DPPH) using portable ESR spectrometer. · can demonstrate the concept of X-Ray diffraction by different crystal structure and analyse the diffraction pattern of those crystal structures to determine the lattice parameter.

		· Hall effect experiment help the students in building the concept of transport properties in semiconductors, Hall coefficient and their dependence of temperature. · With the help of Four Probe method, the students gain the knowledge about the variation of resistivity of the Ge/Si sample with temperature and can determine the energy gap of the sample. · NMR spectrometer enable the students to understand the concept of Zeeman interaction of magnetic dipoles associated with the nucleus and thus, to measure the Lande-g factor of different samples like Glycerine, Copper Sulphate and Iron Chloride etc. · Lattice Dynamics experiment helps the student to understand the concept of acoustical modes, optical modes, and energy gap etc. of mono-atomic and di-atomic lattices.
34.	**Dissertation (B0107U7R, B0108U7R, B0109U12R, B0110U14R)**	· Apply fundamental and disciplinary concepts and methods in ways appropriate to their principal area of study · Demonstrate skill and sound technical and conceptual knowledge of their selected project topic. · Identify, analyse, and solve problems creatively through critical investigation · Demonstrate an awareness and application of appropriate personal, societal and professional ethical standards. · Develop oral and written communication skills · Able to work on research level projects which is suitable to communicate/present in workshops and conferences.