Raniganj Girls' College
Department of Physics

Program Outcome, Program Specific Outcome and Course Outcomes

Programme Outcome	To explore the 'boundless' nature, to unveil its deep secrecy, to dip into the ocean of inherent perfection, broad knowledge in different tools of Physics is inevitable. Having studies through present educational system, Several students have shown bright result leading to their admissions in higher courses like M. Sc. in Physics and Geo-physics and thereafter in research works in our own country and abroad. A lot of students have been settled as teachers in educational institutions. Settlement in Industry based jobs will be welcome in the near future. Six-semester undergraduate courses (Honours, Generic and Program) in Physics are offered under Kazi Nazrul University, Asansol, West Bengal, following the Choice Based Credit System (CBCS), prescribed by the UGC, India. A student may either choose an Honours/Major course in Physics or may opt for Physics as a subsidiary subject. Concerned syllabus is sincerely sown in and got bloomed while cultivating with the students.

Programme Specific Outcome	The tools of Physics as mentioned above, are incorporated well through the prescribed syllabus – whether it is classical, quantum mechanical and statistical, or, it is through electric, electromagnetic, electrodynamics phenomena, electronics, communication and the very concept of relativity, or, involving heat & thermodynamical properties of matter, ray and physical optics and nuclear & particle physics shading light into the very interior of the sub-micro world with a great sense of creation of the ultimate universe. Computational and mathematical methods are highly associated in almost all of the above studies for putting steps forward and for the visualization of the phenomena being studied. Laboratory works (experimental) involved in almost all the theoretical study materials are charming without doubt to prepare oneself in her/his practical (real) life. Skill Enhancement Courses (SEC) with possible hands-on works and relevant projects on electrical and electronics based programs tend to enable one to be skillful enough to help the society as well as well as in one's own household necessities. Computer based knowledge is a key requirement in todays' progress in sustainable development and to acquire in-depth knowledge in a limited time frame. The students are made acquainted with several languages like FORTRAN, C etc. and are pushed them to be habituated in various numerical analyses to see themselves in smoother paths of widening and enhancing their knowledge.

	This is not only for completeness of the syllabus; this is for applying the same for the society and for their own sustainment.

Course Outcomes
➢ Studies on **Classical Mechanics** should enable the students describing the motion of macroscopic objects, from projectiles to parts of machinery, and astronomical objects, such as spacecraft, planets, stars and galaxies. By applying the Newtonian mechanics which consists of the Physical concepts employed and mathematical methods invented by Newton, Gottfried Wilhelm Leibniz and others, one should describe the motion of bodies under the influence of a system of forces. ➢ Having the knowledge of Lagrangian and Hamiltonian mechanics which extend substantially beyond Newton's work, the students should equip themselves to use the same in all areas of M**odern Physics**. ➢ Studies on **Quantum Mechanics** should enable one to describe objects having size of an atomic/subatomic diameter. ➢ Knowledge on **Special Theory of Relativity** would enable one to tackle the phenomena where particles are having velocities not small compared to the speed of light. ➢ Both **Classical Physics** and **Quantum Mechanics** having been learnt, one should be able to differentiate Quantum mechanics from classical physics in that energy, momentum, angular momentum, and other quantities of a bound system are restricted to discrete values (quantization), objects have characteristics of both particles and waves (wave-particle duality), and there are limits to how accurately the value of a physical quantity can be predicted prior to its measurement, given a complete set of initial conditions (the uncertainty principle). ➢ In-depth knowledge would lead one to understand that Early quantum theory was profoundly re-conceived (in the mid-1920s) by Erwin Schrödinger, Werner Heisenberg, Max Born and others; the modern theory is formulated in various specially developed mathematical formalisms, one of which is a mathematical function, the wave function, which provides information about the probability amplitude of energy, momentum, and other physical properties of a particle. ➢ Adequate knowledge in **Statistical mechanics** should enable the students to understand that it is one of the pillars of modern physics and that It is necessary for the fundamental study of any physical system that has many degrees of freedom. The approach is based on statistical methods, probability theory and the microscopic physical laws. ➢ One should be able to know that it (**statistical thermodynamics**) can be used to explain the thermodynamic behaviour of large systems. ➢ Learning through **Statistical mechanics** should show how the concepts from macroscopic observations (such as temperature and pressure) are related to the description of microscopic state that fluctuates around an average state. It connects thermodynamic quantities (such

as heat capacity) to microscopic behavior, whereas, in classical thermodynamics, the only available option would be to measure and tabulate such quantities for various materials.

- Gathering knowledge in **Thermal physics** students should be able to know that it is the combined study of thermodynamics, statistical mechanics, and kinetic theory of gases.

- Knowledge in **Rigid-body dynamics** should lead the students to apply their expertise in the studies of the movement of systems of interconnected bodies under the action of external forces. The dynamics of a rigid body system is described by the laws of kinematics and by the application of Newton's second law (kinetics) or their derivative form Lagrangian mechanics. The solution of these equations of motion provides a description of the position, the motion and the acceleration of the individual components of the system and overall the system itself, as a function of time. The formulation and solution of rigid body dynamics is an important tool in the computer simulation of mechanical systems.

- Deep knowledge in **Electronics** should enable one to understand that it comprises the physics, engineering, technology and applications that deal with the emission, flow and control of electrons in vacuum and matter. One should be able to understand and prepare herself/himself in the practical field, with the knowledge that Electronics is widely used in information processing, telecommunication, and signal processing. The ability of electronic devices to act as switches makes digital information-processing possible. Interconnection technologies such as circuit boards, electronics packaging technology, and other varied forms of communication infrastructure complete circuit functionality and transform the mixed electronic components into a regular working system, called an **electronic system**; examples are computers or control systems. An electronic system may be a component of another engineered system or a standalone device. As of 2019 most electronic devices use semiconductor components to perform electron control. In telecommunication, **communications-electronics** (C-E) is the specialized field concerned with the use of electronic devices and systems for the acquisition or acceptance, processing, storage, display, analysis, protection, disposition, and transfer of information.

- Expertise in **Mathematical physics** should help the students in the development of mathematical methods for application and for the formulations of physical theories.

- Having knowledge in **Computational physics** students should be able to implement the proficiency in numerical analysis to solve problems in physics for which a quantitative theory already exists. Historically, computational physics was the first application of modern computers in science, and is now a subset of computational science. it could be regarded as an intermediate branch between theoretical and experimental physics, a third way that supplements theory and experiment.

- **Computer Applications** also include students' abilities to use word processing, spreadsheet, and database applications software, including integration of applications.

- Knowledge in **Instrumentation which is** is a collective term for measuring instruments that are used for indicating, measuring and recording physical quantities such as flow,

temperature, level, distance, angle, or pressure to students should be able to apply their expertise to devices as simple as direct-reading thermometers, or as complex as multi-sensor components of industrial control systems.

- Students having adequate knowledge in **Nuclear physics** should be able to understand that it is the field of physics that studies atomic nuclei and their constituents and interactions. Proficiency in Nuclear Physics should prepare the students for its application in many fields which include nuclear power, nuclear weapons, nuclear medicine and magnetic resonance imaging, industrial and agricultural isotopes, ion implantation in materials engineering, and radiocarbon dating in geology and archaeology. Particle physics evolved out of nuclear physics and the two fields are typically taught in close association. Nuclear astrophysics, the application of nuclear physics to astrophysics, is crucial in explaining the inner workings of stars and the origin of the chemical elements.

- Adequate familiarity and knowledge in **Particle physics** (also known as **high energy physics**) should enable the students to understand and to make them suitable for higher studies, to the fact that it is a branch of physics that studies the nature of the particles that constitute matter and radiation. Although the word *particle* can refer to various types of very small objects (e.g. protons, gas particles, or even household dust), *particle physics* usually investigates the irreducibly smallest detectable particles and the fundamental interactions necessary to explain their behaviour. By our current understanding, these elementary particles are excitations of the quantum fields that also govern their interactions. The currently dominant theory explaining these fundamental particles and fields, along with their dynamics, is called the Standard Model. Thus, modern particle physics generally investigates the Standard Model and its various possible extensions, e.g. to the newest "known" particle, the Higgs boson, or even to the oldest known force field, gravity.

- **Skill Enhancement Courses** should provide the students the required skill - the ability to carry out a task with determined results often within a given amount of time, energy, or both. Skills can often be divided into domain-general and domain-specific skills. For example, in the domain of work, some general skills would include time management, teamwork and leadership, self-motivation and others, whereas domain-specific skills would be used only for a certain job. Skill usually requires certain environmental stimuli and situations to assess the level of skill being shown and used.

- Having knowledge and hands-on training in **solid-state electronics** should enable the students to apply their expertise in many a field like that involving MOSFET. The MOSFET was the first truly compact transistor that could be miniaturised and mass-produced for a wide range of uses, revolutionizing the electronics industry, and playing a central role in the microelectronics revolution and Digital Revolution. The MOSFET has since become the basic element in most modern electronic equipment, and is the most widely used electronic device in the world.

The Specific Course structure and the outcomes which the students should be involved in, as shaded light in the above, in both theoretical and hands-on training/practical basis are displayed below.	
B. Sc. (Honours) Physics	
Courses	**Outcomes**
Semester -- I	
Core Course-1: Mathematical Methods of Physics-I; Theory.	Essential Mathematical Methods: Calculus, Vector Analysis, Determinant and Matrices, Ordinary Differential Equations, Partial Differential Equations.
Core Course-2: Mechanics; Theory+Lab.	Mechanics of a Single Particle, Mechanics of a System of Particles, Surface Tension, Mechanics of Ideal Fluids and Viscosity, Oscillations.
Semester -- II	
Core Course-3: Mathematical Methods of Physics-II; Theory+Lab.	Fourier Series, Frobenius Method and Special Functions, Some Special Integrals, Theory of Errors, Functions of a complex variable. Basics of scientific computing, C & C++ Programming fundamentals, Programs, Random number generation, Curve fitting, Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method, Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems.
Core Course-4: Electricity and Magnetism; Theory+Lab.	Electric Field and Electric Potential, Dielectric properties of matter, Magnetic field, Magnetic properties of matter, Electromagnetic induction, Electrical Circuits, Ballistic galvanometer, Network theorems. Use a multimeter for measuring (a) Resistances, (b) AC and DC voltages, (c) DC current, (d) Capacitances and (e) Checking electrical fuses; Study response curve of a series LCR circuit and determine its (a) Resonant frequency, (b) impedence at resonance, Quality factor; Parallel LCR circuit, etc.
Semester -- III	
Core Course-5: Classical Mechanics and Special Theory of Relativity; Theory	Kinematics and dynamics of rigid body motion: Rotational motion, Central force motion; Lagrangian and Hamiltonian formulation of classical mechanics: Lagrangian formulation, Hamiltonian formulation; Special theory of relativity.
Core Course-6: Thermal Physics - I; Theory+Lab.	Kinetic theory of gases, Transportation phenomena, Brownian motion and its applications, Real gases, Conduction of heat, Radiation. To determine mechanical equivalent of heat, Coefficient of thermal conductivity, temperature coefficient of resistance, thermo e.m.f. of thermocouple, coefficient of linear expansion, Boiling point by platinum resistace thermometer, etc.
Core Course-7: Analog Systems and ApplicationsI; Theory+Lab.	Semiconductor Diodes, Two-terminal devices and their applications, Bipolar junction transistors, Field Effect transistors, Amplifiers. To design a CE transistor amplifier, digital to analog converter, inverting and non-inverting amplifiers, use of an op-amp as an integrator and differentiator.

Semester -- III **Skill Enhancement Course (SEC-I):**	
1. Electrical Circuits and Network Skills.	Basic electricity principles, Understanding electrical circuits, Electrical drawing and symbols, Generators and transformers, Electric motors, Solid-state devices, Electrical protection, Electrical wiring,.
2. Technical Drawing Skills.	Introduction to drafting instruments and their uses, Projections, Object Projections, CAD drawing,
Semester -- IV	
Core Course-8: Electromagnetic Theory; Theory	Dispersion current, continuity equation, Poynting vector, Maxwell's equations, etc; Wave equations in isotropic and anisotropic dielectrics, waves in conducting medium, Dispersion, Scattering, Electro-and Magneto-optic effects, Acceleration of charged particles by longitudinal and transverse electric fields, Lorentz force.
Core Course-9: Waves and Optics; Theory+Lab	Superposition of collinear and mutually perpendicular harmonic oscillations, wave motions, Interference, diffraction and polarization of light waves. To determine specific rotation using polarimeter, analyze polarized light, determine refractive index of a material using sodium source, to determine dispersive power.
Core Course-10: Digital Systems and Applications; Theory+Lab	Integrated circuits, Digital circuits, Boolean algebra, Data processing circuits, Computer organizations (Input/output devices, idea of RAM and ROM, Memory interfacing and mapping. Use of CRO to measure voltage, time period of a periodic waveform, design a switch (NOT gate), to verify and design AND, OR, NOT and XOR gates using NAND gates, combinational logic system for specific Truth Table, convert a Boolean expression into logic circuit, Half adder, Full Adder, 4-bit binary adder, Subtractors, Flip –Flops, Registers, Multivibrators, etc.
Semester -- IV **Skill Enhancement Course (SEC-II):**	
1. Basic Instrumentation Skills.	Basic measurements like instruments accuracy, precision, sensitivity, resolution etc; Multimeter, Electronic voltmeter, AC millivoltmeter, Cathode Ray Oscilloscope, Sigtnal generators and Analysis instruments, Impedence Bridges & Q-Meters, Digital Instruments, Digital multimeter.
2: Computational Physics.	Highlights the use of computational methods to solve physical problems, Use of computer language as a tool in solving physics problems, Hands on traing on the Problem solving on computers; Algorithms and Flowcharts, Scientific Programming, Control Systems; Scientific word processing: Introduction to LaTeX, Visualization (graphical analysis and its limitation, etc).

Semester – V	
Core Course-11: Quantum Mechanics; Theory+Lab	Old quantum theory, Basic quantum mechanics, Basic postulates, Time dependent and time independent Schrodinger equations, Simple application of Quantum Mechanics. Determine Photoelectric characteristics, measuring Planck's constant, Ionization potential of mercury, absorption lines in rotational spectrum, determine e/m, use of plane transmission grating, etc.
Core Course-12: Thermal Physics-II; Theory	First & 2^{nd} laws of thermodynamics, Thermodynamic functions, Heat engines, refrigerators, Thermodynamics of reversible cells, Change of states, Multicomponent systems, radiation theories and devices.
Semester – V **Discipline Specific Elective (DSE I & II)**	
Physics-DSE: Nuclear and Particle Physics.	General Properties of nuclei, Nuclear models, Radioactive decay, Nuclear reactions, Particle accelerators, Particle Physics.
Physics-DSE: Communication Electronics	Electronic communication, Analog modulation,Analog pulse modulation.
Physics-DSE: Atomic Physics and Spectroscopy.	Atomic spectra, Vector atom model, Many electron model, Molecular spectroscopy, Laser spectroscopy.
Physics-DSE: Astronomi and Astrophysics.	Astronomical scales, Brightness, Radiant flux and Luminosity, Stellar temperature, Measurements of times (Sidereal, Apparent solar, Mean solar), distance, mass, stellar spectral classification, etc., Milky way, Galaxies, Large scale structure & expanding universe.
Semester – VI	
Core Course-13: Statistical Mechanics; Theory	Microstates and macrostates, Classical statistical mechanics, Motivation for quantum statistics, Quantum statistical mechanics: Bose-Einstein and Fermi-Dirac statistics.
Core Course-14: Condensed Matter Physics; Theory	Crystal structure of solids, Elementary lattice dynamics, Dielectric propertis of materials, Elementary band theory, Superconductivity.
Semester – VI **Discipline Specific Elective (DSE III & IV)**	
Physics-DSE: Applied Optics.	Fermat's principle, Matrix method, Different aberrations, Eye pieces, Sources and detectors (including LEDs, Laser), Holography, Fibre optics.
Physics-DSE: Physics of Devices and Instruments.	Devices: Characteristics of UJT, JFET, MOS, MOSFETs, CMOS, Charge coupled devices, Tunnel diodes; Power supply and Filters, Phase locked loop; Processing of devices, Introduction to communication systems.
Physics-DSE: Classical Dynamics.	Calculus of variation, Small amplitude oscillations, Special theory of relativity.

Physics-DSE: Nano Materials and Applications.	Nanoscale systems, Synthesis of nanostructure materials, Characterization, Optical properties, Electron transport, Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells), Micro electromechanical systems (MEMS), Nano electromechanical systems (NEMS), etc.

B. Sc. Programme with Physics	
Semester – I	Elementary vector calculus, Mechanics of a single particle, Mechanics of a system of particles, Rotational motion, Central force motion, Oscillations, Special theory of relativity. Determinations/Measurements of Young's modulus, Rigidity modulus, Surface tension, velocity of sound, Coefficient of viscosity, Acceleration due to gravity (using Bar/Kater's pendulum), Spring constant, Moment of inertia, Resonant length and frequency using sonometer.
Core Course-1: Mechanics; Theory+Lab	
Semester – II	Electric field and potential, Dielectric properties of matter, Magnetic field, Magnetic properties of matter, Electromagnetic induction, Maxwell's equations and Electromagnetic wave propagation, Electrical circuits including series resonance LCR one, Q-factor, band width etc. Use of a multimeter, study of characteristics of RC circuit, to determine low as well as high resistance, self inductance, charge and current sensitivity, etc.
Core Course-2: Electricity and Magnetism; Theory+Lab	
Semester – III	Laws of Thermodynamics, Kinetic theory of gases, Brownian motion and its applications, Theory of radiation, Statistical mechanics. To determine/measure mechanical equivalent of heat, coefficient of thermal conductivity, temperature coefficient of resistance, thermo-emf of a thermocouple, boiling point by platinum resistance thermometer, linear expansion coefficient.
Core Course-3: Thermal Physics and Statistical Mechanics; Theory+Lab	
Semester – IV	Superpositions of collinear and two mutually perpendicular harmonic oscillators, Wave motion, Interference, Diffraction and Polarisation of light waves. To measure polarization, specific rotation, Refractive index, Dispersive power, Wavelength of sodium light, Focal length and power of lenses.
Core Course-4: Waves and Optics; Theory+Lab	
Sem-III: Skill Enhancement Course (SEC-I): SEC 1. Electrical Circuit Network Skills.	Basic electricity principles, Understanding electrical circuits, Electrical drawings and symbols, Generators and Transformers, Solid-state devices (Resistors, inductors, capacitors, Diodes and rectifiers, etc), Electrical protections, Electrical wiring.
Semester - IV	Basic of measurement, Electronic voltmeter, CRO, Signal generators and Analysis instruments, Impedence bridges & Q-meters, Digital instruments, Digital multimeters, Circuit tracing of laboratory electronic equipment, winding a coil/transformer, Layout of receiver circuit, Trouble shooting a circuit, Balancing of bridges.
Basic Instrumentation Skills **(SEC-II)**	

Semester - V Technical Drawing Skills **(SEC-III)**	Introductory study like drafting instruments and their uses, lettering, etc; different Projections like straight line, planes and solid, Object projections, CAD drawing.
Semester - VI Computaional Physics **(SEC-IV)**	Use of computational methods to solve physical problems, Use of computer language as a tool in solving physics problems (applications), Hands on training on training on the problem solving on computers; Algoriths and flowcharts, Scientific programming (FORTRAN), Control systems, DOS, Scientific word processing: LaTeX; Visualization (Graphical analysis).
Discipline Specific Electives (DSE)	
Sem V: Physics DSE I: Modern Physics.	Quantum theory, Structure of solids, Semiconductor physics, Nuclear and Elementary Particle Physics.
Sem V: Physics DSE I: Astronomy and Astrophysics.	Astronomical scales, Astronomical techniques, The Sun (Solar parameters, Solar photosphere, etc; The milky way, Galaxies, Large scale structure & expanding universe.
Sem – VI **Physics DSE-II:** Basic Electronics; Theory+Lab.	Semiconductor devices, Two-terminal devices and their applications, Bipolar junction transistors, Field effect transistors, Ampliiers, Digital circuits, Boolean algebra, Data processing circuits. To design CE transistor amplifier, Digital to Analog converter, AND, OR, NOT and XOR gates using NAND gates, Combinational logic system for a specific Truth Table, Adders and Subtractors, Flip-Flops, 4-bit counter, 4-bit shift register.
Physics DSE-II: Nano materials and Applications; Theory+Lab.	Nanoscale systems, Sunthesis of nanostructure materials, Characterization (invoving X-ray diffraction, Optical microscopy, Scanning Electron microscopy, Transmission electron microscopy, Atomic force microscopy, Scanning tunneling microscopy), Optical properties, Electron transport (Carrier transport in nanostructures, etc), Applications (of nanoparticles, quantum dots, nanowires, thinfilms, etc.). Synthesis of metal and semiconductor , nanoparticles; Fabrication of thin film nanoparticles, etc.

Generic Elective offered by Physics	
Sem I Mechanics; Theory+Lab.	Elementary vector calculus, Mechanics of a single particle, Mechanics of a system of particles, Rotational motion, Central force motion; Oscillations; Special Theory of Relativity. To determine/measure Elastic moduli, Surface tence, resonant length and resonant frequency using sonometer, velocity of sound, Coefficient of viscosity, Acceleration due to gravity (using Bar/Kater's pendulum), Spring constant, Moment of inertia.
Sem II Electricity and Magnetism; Theory+Lab.	Electric field and potential, Dielectric properties of matter, Magnetic field, Magnetic properties of matter, Electromagnetic induction, Maxwell's equations and Electromagnetic wave propagation, Electrical circuits (Kirchhoff's laws, Power dissipation, Quality factor, Band width, etc.). Use of multimeter, measuring low as well as high resistance, self-inductance, LCR-resonant frequency, charge and current sensitivities, etc.
Sem III Thermal Physics and Statistical Mechanics; Theory+Lab.	Laws of thermodynamics, Kinetic theory of gases, Brownian motion and its applications, Theory of radiation, Statistical mechanics. To measure Mechanical equivalent of heat, Coefficient of thermal conductivities of bad as well as good conductors, Temperature coefficient of resistance, Boiling point (by using Platinum resistance thermometer, Thermo-Emf of a thermocouple, Coefficient of linear expansion.
Sem IV Waves and Optics; Theory+Lab.	Superposition of Collinear and two mutually perpendicular harmonic oscillations, Wave motions, Interference, Diffraction and Polarisation of light waves. To measure polarization sate of light, Specific rotation (like that of sugar solution), Refractive index of the material of a prism using sodium source, Dispersive power, wave lengths of light using Biprism, Newton's rings, Plane diffraction grating, focal length and power of lenses.