New Education Policy (NEP) Syllabus

Four-year Undergraduate Programme

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Introduction

Education is fundamental for achieving full human potential, developing an equitable society and promoting national development. Providing universal access to quality education is the key to India's continued ascent and leadership on the global stage in terms of economic growth, social justice and equality, scientific advancement, national integration and cultural preservation. For the purpose of developing holistic individuals, it is essential that an identified set of skills and values will be incorporated at each stage of learning, from pre-school to higher education. Higher education must form the basis for knowledge creation and innovation thereby contributing to a growing national economy. The purpose of quality higher education is, therefore, more than the creation of greater opportunities for individual employment. It represents the key to more vibrant, socially engaged, cooperative communities and a happier, cohesive, cultured, productive, innovative, progressive and prosperous nation. The NEP-2020 offers holistic and multidisciplinary education system for students. The learning outcome-based curriculum framework for a degree in B.Sc. (Honours) Physics is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Physics, as well as to develop scientific orientation, spirit of acquiring problem solving skills and human and professional values which foster rational and critical thinking in students.

Some of the characteristic attributes a graduate in Physics should possess are:

- Disciplinary knowledge and skills
- Skilled communication
- Critical thinking and problem-solving capacity
- Sense of inquiry
- Team player/worker
- Project Management Skills
- Digital and ICT efficiency
- Ethical awareness/reasoning
- National and international perspective
- Lifelong learning

Aims of UG program in Physics

The aims and objectives of our UG educational programs in sciences in general and Physics in particular should be structured to

- Create the facilities and environment in all the educational institutions to consolidate the knowledge acquired at 10+2 level and to motivate and inspire students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.

- Learn, design and perform experiments in labs to demonstrate the concepts, principles and theories learned in the classrooms.
- Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
- Exposure of students to the vast scope of Physics as a theoretical and experimental science with applications in solving most of the problems in nature.
- Emphasize the discipline of Physics to be the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
- To emphasize the importance of Physics as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

The progressive curriculum should be able to position knowledge and skills in such a way that it can give a way for transformation of a novice problem solvers (at entry level of the program) to expert problem solvers (by the time of graduation) as given below:

- At the end of first year – Ability to solve well defined problems
- At the end of second year – Ability to solve broadly defined problems
- At the end of third year – Ability to solve complex problems that require multi-disciplinary skills to solve them
- During fourth year – Experience of workplace problem solving in the form of internship or research experience preparing for higher education, research, entrepreneurship and employment.

Curriculum Framework for Four- year Undergraduate Programme

Graduate Attributes

The disciplinary expertise or technical knowledge formes the core of university courses and these are the qualities that prepare graduates as agents for social good in future. Some of the characteristic attributes that a graduate should demonstrate are as follows:

1. **Disciplinary knowledge**: Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines
2. **Research-related skills**: A sense of inquiry and capability for asking relevant and appropriate questions.
3. **Analytical reasoning**: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others.
4. **Critical thinking**: Capability to apply analytic thought to a body of knowledge.
5. **Problem solving**: Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems.
6. **Communication Skills**: Ability to express thoughts and ideas effectively in writing and orally.
7. **Information/digital literacy**: Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate and use a variety of relevant information sources and use appropriate software for analysis of any data.
8. **Self-directed learning**: Ability to work independently, identify appropriate resources required for a project and manage a project through completion.
9. **Cooperation/Team work**: Ability to work effectively and respectfully with diverse teams.
10. **Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective.
11. **Reflective thinking**: Critical sensibility to live experiences, with self-awareness and reflexivity of both self and society.
12. **Multicultural competence**: Possess values and beliefs of multiple cultures and have a global perspective.
13. **Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one’s life, formulate a position/argument about an ethical issue from multiple perspectives and use ethical practices in all work.
14. **Leadership readiness/qualities**: Capability for mapping out the tasks of a team or an organization and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.
15. **Lifelong learning**: Ability to acquire knowledge and skills, including ‘learning how to learn’, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Outcomes (POs) for Undergraduate programme (Honours)

POs are statements that describe what the students graduating from any of the educational programmes should be able to do. They are the indicators of what knowledge, skills and attitudes a graduate should have at the time of graduation.

1. **In-depth knowledge:** Understand the concepts and processes related to an academic field of study and demonstrate the applicability of their domain knowledge and its links to related disciplinary areas/subjects of study.
2. **Specialised knowledge and skills**: Demonstrate procedural knowledge and skills in areas related to one's specialization and current developments, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialisation.
3. **Analytical and critical thinking:** Demonstrate independent learning, analytical and critical thinking of a wide range of ideas and complex problems and issues.
4. **Research and Innovation**: Demonstrate comprehensive knowledge about current research in the subject of specialisation; critical observation to identify research problems and to collect relevant data from a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the area of specialisation for formulating evidence-based research output.
5. **Interdisciplinary Perspective:** Commitment to intellectual openness and developing understanding beyond subject domains.
6. **Communication Competence:** Demonstrate effective oral and written communicative skills to covey disciplinary knowledge and to communicate the results of studies undertaken in an academic field accurately in a range of different contexts using the main concepts, constructs and techniques of the subject(s) of study
7. **Career development:** Show proficiency in academic, professional, soft skills and employability required for higher education and placements.
8. **Teamwork:** Work in teams with enhanced interpersonal skills leadership qualities.
9. **Commitment to the society and the Nation**: Recognise the importance of social, environmental, human and other critical issues faced by humanity at the local, national and international level; appreciate the pluralistic national culture and the importance of national integration.

Programme Specific Outcomes (PSOs) in Physics

Programme specific outcomes include subject-specific skills and generic skills, including transferable global skills and competencies, the achievement of which the students of a specific programme of study should be able to demonstrate for the award of the degree. The programme specific outcomes would also focus on knowledge and skills that prepare students for further study, employment and to become a concern citizen. They help ensure comparability of learning levels and academic standards across universities and provide a broad picture of the level of competence of graduates of a given programme of study. The attainment of PSOs for a programme is computed by accumulating PSO attainment in all the courses comprising the programme.

PSO1- Basic Concept: Ability to interpret and analyse various concepts so that students will be able to demonstrate proficiency in Mathematics and the mathematical concepts needed for a proper understanding of Physics.

PSO2- Understanding Problems: An understanding of the various problems in Physics which will inculcate logical thinking.

PSO3- Understanding of the subject: Students will acquire core knowledge in Physics, including the major premises of Mechanics and Properties of matter, Modern Physics, Classical and Quantum mechanics, Electricity and Magnetism, Digital Electronics, Optics, Relativity, Heat and Thermodynamic, Solid-State Physics, Mathematical and Statistical physics, Atomic, Molecular and Nuclear Physics, Laser and nonconventional energy sources.

PSO4- Laboratory Knowledge: Students will learn how to design and conduct an experiment and understand the basic physics behind it. Moreover, students will develop proficiency in handling laboratory instruments.

PSO5- Application of the subject: Students will realize and develop an understanding of the impact of Physics on society and apply conceptual understanding of the physics in real life.

PSO6- Motivation for research: Students will develop aptitude of doing research through undertaking small projects and research centre visit.

Programme Outcomes (POs) matrix

Programme Outcomes (POs)	PHY101 (Major/Minor)	MDE (SEM I/II)	PHY201 (Major/Minor)	MDE (SEM I/II)
1. In-depth knowledge	✓		✓	
2. Specialized knowledge and skills	✓		✓	
3. Analytical and critical thinking	✓	✓	✓	✓
4. Research and Innovation				
5. Interdisciplinary Perspective		✓		✓
6. Communication Competence	✓	✓	✓	✓
7. Career development	✓	✓	✓	✓
8. Teamwork	✓	✓	✓	✓
9. Commitment to the society and the Nation	✓	✓	✓	✓

Programme Specific Outcomes (PSOs) matrix

Programme Specific Outcomes	PHY101 (Major/Minor)	MDE (SEM I/II)	PHY201 (Major/Minor)	MDE (SEM I/II)
Basic Concepts	✓	✓	✓	✓
Understanding Problems	✓		✓	
Understanding of the subject	✓	✓	✓	✓
Laboratory Knowledge	✓		✓	
Application of the subject	✓		✓	
Motivation for research				

Paper code and Paper Names for different Semesters, 2023
UG: B.Sc. (Physics honours)

SEM	Paper Code	Paper Name	Credit
SEM-I	PHY101 (Major/Minor)	Mathematical Physics and Mechanics	3+0+1=4
	MDE-1	Introduction to Physics-I	2+1+0=3
	AEC-1	English Communication-I	2
	SEC-1	Basics of Instruments	1+1+1=3
	VAC-1	Offered by University	4
SEM-II	PHY201 (Major/Minor)	Mathematical Physics & Electricity and Magnetism	3+0+1=4
	MDE-2	Introduction to Physics-I	2+1+0=3
	AEC-2	MIL-I	2
	SEC-2	Introduction to Python	1+1+1=3
	VAC-2	Offered by University	4
SEM-III	PHY301	Waves and Optics	3+0+1=4
	PHY302	Current Electricity	3+0+1=4
	Minor	Wave and Optics	3+0+1=4
	MDE-3	Introduction to Physics-II	3
	AEC-3	English Communication-II	2
	SEC-3	Electronics Design and Fabrication	1+1+1=3
SEM-IV	PHY401	Mathematical Physics-I	4+0+0=4
	PHY403	Analog Electronics	3+0+1=4
	PHY404	Heat and Thermodynamics	3+0+1=4
	Minor	Heat and Thermodynamics	3+0+1=4
	AEC-4	MIL-II	2
	Summer Internship		2
SEM-V	PHY501	Classical Mechanics	4+0+0=4
	PHY502	Condensed Matter Physics	3+0+1=4
	PHY503	Quantum Mechanics-I	3+0+1=4
	PHY504	Digital Electronics	3+0+1=4
	Minor	Electromagnetic Theory	4+0+0=4
SEM-VI	PHY601	Nuclear and Particle Physics	3+0+1=4
	PHY602	Electromagnetic Theory	3+0+1=4
	PHY603	Astronomy and Astrophysics	4+0+0=4
	PHY604	Statistical Mechanics	3+0+1=4
	Minor	Classical Mechanics	3+0+1=4
SEM-VII	Core-1	Quantum Mechanics-II	4+0+0=4
	Core-2	Atomic and Molecular Physics	3+0+1=4
	Core-3	Research Methodology	4+0+0=4
	Core-4	Experimental Techniques	3+0+1=4
	Minor	Elements of Modern Physics	4+0+0=4

	Dissertation/Project of 12 credits over Semesters VII and VIII, for Honours with Research Degree, only if CGPA ≥ 7.5 up to Semester VI. Portion of the work equivalent to 4 credits will be for evaluation during this semester. * Other students must take Core 4 in this semester.		
SEM-VIII	Core-1	Mathematical Physics-II	4+0+0=4
	Core-2	Introduction to Field Theory	4+0+0=4
	Core-3	Atmospheric Physics	4+0+0=4
	Core-4	Medical Physics	3+0+1=4
	Minor	Solid State Physics	4+0+0=4
	Dissertation Project Portion of the work equivalent to the remaining 8 credits will be evaluated during this semester. * Students not having dissertation/project must take Core 3 and Core 4 in this semester.		8

Semester: I
PHY101 (Major/Minor): Mathematical Physics and Mechanics
Credits: 3+0+1
Theory: 45 Lectures

Title of the paper: Mathematical Physics and Mechanics
Code: PHY 101
Credit: L=3, T=0, P=1
Total No. of Lectures: 45
Course Objective: This course introduces Mathematical Physics and Mechanics. The basic objectives of the course are ➢ To introduce essential primary concepts in Mathematical Physics such as calculus of vectors, curvilinear coordinates and Dirac delta function which are required for developing insight of the theories of Physics. ➢ To introduce the concepts of dynamics of particles, energy, oscillation and basic properties of matter which will equip students with the tools required for applying the concepts of physics in practical problems. ➢ To train the students with concept of visualization through some laboratory practices.
Learning Outcome: ➢ On successful completion of the course, students will be able to understand the calculus of vectors and concept of curved spaces which play central roles in developing insight of the theories of physics. ➢ They will learn the powerful method of computation through Dirac delta function which often appears in complex problems of physics. ➢ Students will be able to understand and apply the concepts of dynamics of particles, energy, oscillation and basic properties of matter in various problems of physics, technology and engineering. ➢ They will be trained in concept realization through laboratory practices.
Reference Books: 1. Mathematical Methods in the Physical Sciences, Mary L. Boas, Wiley. 2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, Elsevier. 3. Schaum Series, Vector Analysis, Murray Speigel, Tata McGraw-Hill. 4. Essential Mathematical Methods for the Physical Sciences; K.F. Riley and M.P. Hobson, Cambridge University Press. 5. Advanced Engineering Mathematics; E. Kreyszic, John Wiley & Sons (New York). 6. Theoretical Mechanics, M. R. Spiegel, Tata McGraw Hill. 7. Mechanics; D. S. Mathur, S. Chand & Company Limited. 8. An Introduction to Mechanics, D. Kleppner and R. J. Kolenkow, Tata McGraw-Hill. 9. Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al., Tata McGraw-Hill. 10. Physics, R. Resnick, D. Halliday and J. Walker, John Wiley & Sons. 11. Analytical Mechanics, G. R. Fowles and G. L. Cassiday, Cengage Learning.

Part A: Mathematical Physics

Unit I: Vector Calculus

Scalar and vector fields. Derivatives of vector functions (physical examples-velocity, centripetal acceleration of a point in circular motion). Directional derivative. Gradient of a scalar field (example of Newton's gravitational force as gradient of a scalar potential). Gradient as normal vector to a surface. Divergence and curl of a vector field- solenoidal and irrotational vector fields. Laplacian operator (physical problems – Laplacian of gravitational potential, divergence of central force). Vector identities. Vector integration - Line integral (physical example - work done by a force, path dependence/independence and concept of conservative force). Surface and volume integrals. Concept of vector flux. Gauss's divergence theorem and Stokes's theorem. Application of different theorems in problem solving.

(15 lectures)

Part B: Mechanics

Unit I: Reference frames

Inertial frames. Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

(5 lectures)

Unit II: Gravitation and central force motion

Motion under central force. Two-body problem and its reduction to one body problem. Kepler laws, Gravitational potential and fields due to spherical body. Gauss's law and Poisson's equation for gravitational field.

(7 lectures)

Unit III: Conservation laws

Dynamics of a system of particles. Centre of mass. Principle of conservation of momentum. Torque. Impulse. Elastic and inelastic collisions between particles. Centre of mass and laboratory frames.

(6 lectures)

Unit IV: Dynamics of rigid bodies

Rigid body motion. Rotational motion. Moment of inertia of rectangular lamina, disc, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation. Numerical problems involving concepts of rotational dynamics.

(7 lectures)

Unit V: Work and energy

Work and kinetic energy theorem. Conservative and non-conservative forces. Potential energy. Force as gradient of potential energy. Work and potential energy. Work done by nonconservative forces.

(5 lectures)

Laboratory

1. Measurements of length (or diameter) using vernier calliper, screw gauge and travelling microscope and study of errors in measurements.
2. To study the motion of spring and calculate (a) spring constant and (b) rigidity modulus.
3. To determine the moment of inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
4. To determine coefficient of viscosity of water by capillary flow method (Poiseuille's method).
5. To determine the Young's modulus of the material of a wire by Searle's apparatus.
6. To determine the modulus of rigidity of a wire (static method).
7. To determine the value of g using bar pendulum.
8. To determine the value of g using Kater's pendulum.

Semester: I/II
MDE (SEM I/II): Introduction to Physics-I
Credits: 2+1+0
Theory: 34 Lectures

Title of the paper: Introduction to Physics-I
Code: MDE 1
Credit: L=2, T=1, P=0
Total No. of Lectures: 34
Course Objective ➢ To give an introduction to evolution of Physics. ➢ To give introductory concepts on electricity and magnetism. ➢ To provide preliminary idea on atomic structure, thermodynamics and optical fibre.
Learning outcome ➢ On successful completion of the course, students will be able to understand the preliminary idea on evolution of Physics. ➢ They will understand the basic concepts of electricity and magnetism which are the fundamental parts of Physics. ➢ They will have an idea of atomic spectra, nuclear energy, optical fibre and basic concepts of thermodynamics.
Reference Books: 1. Fundamentals of Physics, Halliday, Resnick and Walker, Publisher: Wiley. 2. Conceptual Physics, Paul G. Hewitt, Publisher: Pearson. 3. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill. 4. Feynman Lectures in Physics Vols. I-III, Pearson.

Evolution of Physics:
Early era; Scope and excitement of Physics, Evolution of Physics: Theoretical progress and consequent experimental results, Relation of Physics to other Sciences, Physics technology and society.

(6 Lectures)

Time and distance, Motion, Force, Newton's laws of dynamics, Conservation of momentum

(6 Lectures)

Theory of gravitation, acceleration due to gravity, Kepler's laws, artificial satellite.

(2 Lectures)

Fundamental forces in nature.

(2 Lectures)

Electricity:
Conductor, Insulators, Properties of charge, Coulomb's law, Electric field, Electric potential. Cell and emf.

(3 Lectures)

Electric current, Ohm's law, Resistance.

(2 Lectures)

Magnetism:
Bar magnet, The Earth's magnetism, Permanent magnet and electromagnet.

(3 Lectures)

Optics:
Reflection and refraction of light, refraction through lens, refraction through prism, dispersion, Total internal reflection, mirage, optical fiber (qualitative discussion)

(3 Lectures)

Matter:
Atom, Atomic structure (qualitative), Atomic spectra, Nucleus, Nuclear Energy.

(3 Lectures)

Heat and Temperature, Units of temperature, Change of state, Latent heat, Heat transfer: Conduction, Convection, Radiation (qualitative).

(4 Lectures)

Semester: I
SEC-I: Basics of Instruments
Credits: 1+1+1
Theory: 34 Lectures

Title of the paper: Basics of Instruments

Code: SEC-I

Credit: L=1, P=1, F=1

Total No. of Lectures: 34

Course Objective

- To expose the students to various aspects of instruments and their usage through hands-on mode.
- To provide them a thorough understanding of basics of measurement, measurement devices such as electronic voltmeter, oscilloscope, signal and pulse generators, impedance bridges, digital instruments etc.

Learning outcome

- The student is expected to have the necessary working knowledge on accuracy, precision, resolution, range and errors/uncertainty in measurements.
- Students learn the use of CRO for the measurement of voltage (DC and AC), frequency and time period.
- Covers the explanation and specifications of signal and pulse generators: low frequency signal generator and pulse generator.
- Students learn about the working principles and specifications of basic LCR Bridge.

Reference Books:

1. Logic circuit design, Shimon P. Vingron, 2012, Springer.
2. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
3. Electronic Devices and circuits, S. Salivahanan and N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
4. Digital Circuits and Systems, Venugopal, 2011, Tata McGraw Hill.
5. Electronic Instrumentation, H.S. Kalsi, 3rd Ed. Tata McGraw Hill.
6. A text book in Electrical Technology - B L Theraja - S Chand and Co.
7. Performance and design of AC machines - M G Say ELBS Edn.

Basics of Measurement: Instruments accuracy, precision, sensitivity, resolution, range etc. Errors in measurements. Working principle of time interval, frequency and period measurement.
Multimeter: Measurement of dc voltage and dc current, ac voltage, ac current and resistance and compare the resistance using colour code. Specifications of electronic voltmeter/multimeter and their significance. AC milli-voltmeter, working of a digital multimeter.
Cathode Ray Oscilloscope: Specifications of CRO with block diagram and their significance. Measurement of voltage (dc and ac), frequency and time period. Special features of dual trace.
Signal and Pulse Generators: Block diagram and specifications of low frequency signal and pulse generators.
Impedance Bridges: Block diagram, working principles of RLC Bridge. Specifications of RLC Bridge. Digital LCR bridges.

List of Experiments:
1) Measurements of length (or diameter) using vernier calliper, screw gauge, and travelling microscope and study of errors in measurements.
2) Measurement of dc voltage and dc current, ac voltage, ac current and resistance using digital multimeter.
3) To find the resistances of fixed resistors using colour code and verify using multimeter.
4) To observe the limitations of a multimeter for measuring high frequency voltage and currents.
5) Measurement of voltage, frequency, time period and phase using an oscilloscope.
6) Measurement of rise, fall and delay times using oscilloscope.
7) Measurement of R, L and C using LCR Bridge.
8) Measurement of Q-factor in LCR circuit.

Demonstration of sophisticated instruments:
1) Digital Storage Oscilloscope
2) Spectrometer
3) Diffraction of LASER using grating.
4) Millikan oil drop experiment
5) GM Counter
6) Demonstration of discharge tube

Semester: II
PHY201 (Major/Minor): Mathematical Physics & Electricity and Magnetism
Credits: 3+0+1
Theory: 45 Lectures

Title of the paper: Mathematical Physics & Electricity and Magnetism
Code: PHY 201
Credit: L=3, T=0, P=1
Total No. of Lectures: 45
Course Objective: ➢ To introduce the methods of solving differential equations. ➢ To introduce various concepts of matrix algebra. ➢ Electric field from vector calculus point of view and use of potential formulation to solve electrostatic problems. ➢ Magnetic fields of current carrying conductors, torus, solenoids etc. Study magnetic properties of matter. ➢ Study and analysis of AC circuits like LCR and use of network theorems in electrical circuits.
Learning outcome: ➢ After the successful completion of the course, students will be able to understand methods of solving various differential equations appearing in physics. It will give an idea of how to study evolution of a physical system. ➢ Through matrix algebra students will be able to compute various matrix operations which are required for solving physical problems. ➢ They will be able to understand electric field and magnetic fields in matter, dielectric properties of matter, magnetic properties of matter, application of Kirchhoff's law in different circuits and application of network theorem in different circuits. ➢ The students will also get accustomed to using multimeters and potentiometers and they will be able to determine some of the important physical quantities related to electricity and magnetism for a better understanding of the topic.
Reference Books: 1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber and F.E. Harris, Elsevier. 2. Differential Equations, George F. Simmons, McGraw Hill. 3. An introduction to ordinary differential equations, E.A. Coddington, PHI learning. 4. Mathematical Physics, H. K. Dass and Dr. Rama Verma, S. Chand Publication. 5. Advanced Engineering Mathematics, E. Kreyszic, John Wiley & Sons. 6. Essential Mathematical Methods for the Physical Sciences, K. F. Riley and M. P. Hobson, Cambridge University Press. 7. Introduction to Electrodynamics, D. J. Griffiths. 8. Principles of Electromagnetics, M.N. Sadiku, Oxford. 9. Electricity and Magnetism, Edward M. Purcell, Cambridge University Press. 10. Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and S. R. Choudhury, Tata Mcgraw Hill. 11. Electromagnetics, B. B. Laud, New Age International Publishers. 12. Electricity and Magnetism, J. W. Fewkes and J. Yarwood, Vol. I, Oxford Univ. Press.

Part A: Mathematical Physics

Unit 1: Differential equations

First and second order ordinary differential equations (ODE). Homogeneous and inhomogeneous differential equations. Solutions of first order ODE - integrating factors (physical examples - radioactive decay, Newton's law of cooling, particle falling under gravity through a resistive medium). Concept of initial/boundary conditions. Solutions of second order ODE with constant coefficients - complementary function and particular integral (physical examples - simple harmonic oscillation, forced vibration). Wronskian - definition and its use to check linear independence of 2^{nd} order homogeneous linear differential equation.
Partial differential equations (PDE) (physical examples - wave equation, diffusion equation, Laplace and Poisson equation – introduction only). Exact and inexact differentials. Concept of variable separation in a PDE.

(15 lectures)

Part B – Electricity and Magnetism

Unit I: Electric field and electric potential

Electrostatic field, electric flux. Gauss's law. Application of Gauss's law to charge distributions with planar, spherical and cylindrical symmetries. Conservative nature of electrostatic field. Electrostatic potential. Electrostatic energy of a system of charges. Electrostatic boundary conditions. Laplace's and Poisson's equations. Uniqueness theorem. Application of Laplace's equation involving planar, spherical and cylindrical symmetries. Potential and electric field of a dipole. Force and torque on a dipole. Capacitance of a system of charged conductors. Parallel plate capacitor. Capacitance on an isolated conductor.

(15 lectures)

Unit II: Dielectric properties of matter

Electric field in matter. Polarisation, polarisation charges. Electrical susceptibility and dielectric constant. Capacitor (parallel plate, spherical and cylindrical) filled with dielectric. Displacement vector, $\vec{D}$, Relation between $\vec{E}$, $\vec{P}$, and $\vec{D}$. Gauss's law in dielectrics.

(5 lectures)

Unit III: Magnetic field

Magnetic force on a point charge, definition and properties of magnetic field $\vec{B}$. Curl and divergence. Vector potential, $\vec{A}$. Magnetic scaler potential. Magnetic force on (*i*) a current carrying wire and (*ii*) between two elements. Torque on a current loop in a uniform magnetic field. Biot-Savart's law and its simple application: straight wire and circular loop. Current loop as a magnetic dipole and its dipole moment (analogy with electric dipole). Ampere's circuital law and its application to (*i*) solenoid and (*ii*) torus.

(10 lectures)

Laboratory

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De' Sauty's bridge.
6. Measurement of field strength $\vec{B}$ and its variation in a solenoid (determine $\frac{d\vec{B}}{dx}$).
7. To verify the Thevenin and Norton Theorems.
8. To verify the superposition and maximum power transfer theorems.
9. To determine the self-inductance of a coil by Anderson's bridge.
10. To study the response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer.
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine the self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by the Absolute method.

Semester: II
SEC-II: Introduction to Python
Credits: 1+1+1
Theory: 34 Lectures

Title of the paper: Introduction to Python
Code: SEC-II
Credit: L=1, P=1, F=1
Total No. of Lectures: 34
Course Objective ➢ The objective of this course is to teach computer programming and basic idea of numerical analysis, emphasizing its role in solving problems in Physics, and other fields.
Learning outcome ➢ Use computers for solving problems in Physics. ➢ Prepare algorithms and flowcharts for solving a problem. ➢ Design, code and test simple programs in Python in the process of solving various problems. ➢ Visualize data and functions graphically.
Reference Books: 1. Head-First Python: A Brain-Friendly Guide, Paul Barry. 2. Learn Python the Hard Way, Zed A. Shaw. 3. Learning Python, Mark Lutz. 4. Elements of Programming Interviews in Python: The insider's Guide, Adnan, Amit, and Tsung-Hsien. 5. Computational Physics, Darren Walker, 1st Edn., Scientific International Pvt. Ltd (2015).

Introduction:
Binary and decimal arithmetic, Floating point numbers, single and double precision arithmetic, underflow and overflow, numerical errors of elementary floating-point operations, round off and truncation errors with examples. Introduction to Algorithms and Flow charts. Branching with examples of conditional statements, for and while loops.
Basic Elements of Python:
The Python interpreter, the print statement, comments, Python as simple calculator, objects and expressions, variables(numeric and sequence types) and assignments, mathematical operators. Help in Python, Strings, Lists, Tuples and Dictionaries, type conversions, input statement, list methods. List mutability, Formatting in the print statement.
Control Structures:
Conditional operations, if, if-else, if-elif-else, while and for Loops, indentation, break and continue, List comprehension. Functions: Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules. File Handling: ‘r’, ‘w’, ‘a’ modes, Reading from files and writing into text and csv files. Exception handling with try-except, the with statement.
Functions:
Inbuilt functions, user-defined functions, local and global variables, passing functions, modules, importing modules, math module, making new modules.

List of Programs:
• To calculate area of a rectangle
• To check size of variables in bytes (Use of size of Operator)
• Converting plane polar to Cartesian coordinates and vice versa
• To find roots of a quadratic equation
• To find largest of three numbers
• To check whether a number is prime or not
• To list Prime numbers up to 1000

Recommended List of Programs
(a) Make a python function that takes a number N as input and returns the value of factorial of N and compare with the output of math.factorial() method. Use this function to print the number of ways a set of m red and n blue balls can be arranged.
(b) Generate random numbers (integers and floats) in a given range and calculate area and volume of regular shapes with random dimensions.
(c) Generate data for coordinates of a projectile and plot the trajectory. Determine the range, maximum height and time of flight for a projectile motion.