Bachelor of Science
B.Sc. Physics (Semester -IV)

Course Code	US04CPHY51	Title of the Course	Electromagnetic Theory and Spectroscopy
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	The students will be benefited by studying: 1. concept of Gradient, Divergence and Curl and different coordinate systems 2. concept of charge its field & it's energy density and Poisson's and Laplace's equation. 3. magnetic field and its force, motion of charged particle in magnetic field, Biot-Savart law and its application to find the magnetic flux & div & curl of B 4. concept of magnetic material 5. investigation and production of spectra and various types of spectra and different Quantum number. 6. the effects of magnetic and electric field on the spectrum of an atom i.e., Zeeman effects, Paschen-Back effects and Stark effects. 7. Production, measurement and diffraction of X - ray radiation and Bragg's Law. 8. comparison of optical and X-Ray spectra.

Course Content

Unit	Description	Weightage* (%)
1	**Electrostatics** **Electric field:** Brief introduction to Gradient, Divergence and Curl, Line, Surface and Volume integrals, Spherical and Cylindrical Coordinate Systems, The Dirac delta function, Coulomb's Law, The Electric field, Continuous charge distribution, Divergence and curl of Electrostatic fields: Field lines, Flux and Gauss's law, The Divergence of E, Applications of Gauss's law. The Curl of E, **Electric Potential:** Introduction to potential, Comments on potential, Poisson's equation and Laplace's equation, The potential of a localized charge distribution, Boundary conditions, Work and Energy in **Electrostatics:** The work done to move a charge, The energy of a point charge distribution, The energy of a continuous charge distribution [Introduction to Electrodynamics by David J Griffiths, (3rd Edition) Prentice-Hall of India Private Ltd. **Electrostatics:** 1.2.2, 1.2.4, 1.2.5, 1.3.1, 1.4.1, 1.4.2, 1.5.1, 1.5.2, 1.5.3, 2.1.2, 2.1.3, 2.1.4, 2.2, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.3.3, 2.3.4, 2.3.5, 2.4, 2.4.1, 2.4.2,2.4.3]	25 %

2.	**Magnetostatics** **The Lorentz Force Law:** Magnetic fields, Magnetic forces, Cyclotron motion, Cycloid motion, Currents, **The Biot-Savart law:** Steady currents, The Magnetic field of a steady current and its applications, **The Divergence and Curl of B:** Straight-Line currents, The Divergence and Curl of B**,** Ampere's law and its applications, Comparison of Magnetostatics and Electrostatics, **Magnetic Vector Potential:** The Vector potentia**l,** Boundary conditions, **Magnetization:** Diamagnets, Paramagnets, Ferromagnets, Torques and forces on magnetic dipoles, Effect of a magnetic field on atomic orbits [Introduction to Electrodynamics by David J Griffiths, (3rd Edition) Prentice-Hall of India Private Ltd, **Magnetostatics:** 5.1,5.1.1, 5.1.2, 5.1.3, 5.2, 5.2.1, 5.2.2, 5.3, 5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.4, 5.4.1, 5.4.2, 6.1, 6.1.1, 6.1.2, 6.1.3]	25 %
3.	**Atomic Spectra** Investigation of Spectra, Production of Spectra, Types of Spectra, Wave Number, Shortcomings of Bohr theory, Criticism and limitations of old quantum mechanical models, The Spinning Electron, Space Quantization, Quantum Numbers and their Physical Interpretation, Fine structure of Hydrogen atom, Spectral terms and their notations, Positronium, Mesonic atoms, L-S Coupling, J-J Coupling, Experimental study of Zeeman Effect, Classical Interpretation of Normal Zeeman Effect, Vector model and normal Zeeman effect, Paschen-Back effect, Stark Effect. [Elements of Spectroscopy by S L Gupta, V Kumar, R C Sharma (29th Edition) Section I : Atomic Spectra: 1.1, 1.2, 1.3, 1.4,1.14, 2.7, 3.1, 3.2, 3.3, 3.1.1, 3.8, 3.9, 3.10, 3.11, 6.13, 9.1, 9.2, 9.3, 9.4, 9.7, 9.14]	25 %
4.	**X-ray Spectra** Production of X-rays, Origin of X-Radiations according to electromagnetic theory, X-rays, Light and Electromagnetic Spectrum, Measurement of X-Radiations, Diffraction of X-Radiations, Bragg's law, Laue spots, Bragg's spectrometer, Continuous X-ray spectrum, Characteristic Emission Spectrum, Characteristic absorption Spectrum, A Close Survey of Emission Spectrum, Explanation of Emission and Absorption Spectra, Energy levels, Comparison of Optical and X-ray Spectra, Moseley's Law, The Fluorescence yield and Auger Effect, Satellites. [Elements of Spectroscopy by S L Gupta, V Kumar, R C Sharma (29th Edition) Section II : X-Rays and X-Ray Spectra: 1.1, 1.2, 1.3, 1.4, 1.6, 1.7, 1.8, 1.9, 1.12, 1.13A, 1.13B, 1.14, 1.15, 1.16, 1.17, 1.21, 1.22]	25 %

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Class discussion led by teacher/students Case Studies Literature review Problem solving activities Debate Collaborative and Co-operative Learning Think Pair Share Jigsaw Inquiry Based Learning Panel Discussion Project Based Learning Flipped Classroom Blended Learning designs Concept Mapping

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the different type of Electric field, Electric potential theory.
2.	Understand the Magnetostatics and Magnetization theory.
3.	Understand about Production and types of Atomic spectra and effects of magnetic and electric field on it.
4.	Understand the various parameters related with X-Ray Spectra.

Suggested References:	
Sr. No.	References

1.	Introduction to Electrodynamics David J Griffiths, (3rd Edition) Prentice-Hall of India Private Ltd.
2.	Elements of Spectroscopy S L Gupta, V Kumar, R C Sharma (29th Edition) Pragati Prakashan
3.	Electricity and Magnetism A S Mahajan and A A Rangwala ,Tata McGraw Hill Publishing Company Ltd
4.	Molecular structure and Spectroscopy G Aruldhas, Prentice-Hall of India Private Limited

On-line resources to be used if available as reference material
On-line Resources
https://andrealommen.github.io/PHY309/lectures/divcurlE Divergence and Curl and Gauss's law related theory
https://opentextbc.ca/calculusv3openstax/chapter/cylindrical-and-spherical-coordinates/ Spherical and Cylindrical coordinate system
https://www.accessengineeringlibrary.com/content/book/9781260120974/chapter/chapter6# work and energy in electrostatics
https://en.wikipedia.org/wiki/Magnetostatics#:~:text=Magnetostatics%20is%20the%20study%20of,where%20the%20charges%20are%20stationary. Magnetostatics and related theory
https://en.wikipedia.org/wiki/Magnetization Magnetization and related theory
https://thefactfactor.com/facts/pure_science/physics/ferromagnetic/4702/ Diamagnetic, Paramagnetic and ferromagnetic materials
https://www.youtube.com/watch?v=FLQXW6G9P8I Related videos of spherical and cylindrical coordinate system https://www.youtube.com/watch?v=wsCMXfQWnyM Related videos of Work and energy in electrostatics
https://en.wikipedia.org/wiki/Zeeman_effect Zeeman effect
https://www.youtube.com/watch?v=vSIVDEV1v78 Atomic spectra absorption and emission spectra
https://www.radiologymasterclass.co.uk/tutorials/physics/x-ray_physics_production Production of X-ray and X- Radiation

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Bachelor of Science
B.Sc. Physics (Semester-IV)

Course Code	US04CPHY52	Title of the Course	Classical, Quantum and Solid-State Physics
Total Credits of the Course	04	Hours per Week	04

Course Objectives:	This will be help students to learn: 1. the fundamentals of inverse square law – forces and motions. 2. the concepts of Quantum Mechanics based on Schrödinger wave equation formulation. 3. basic concepts of crystallography and crystal analysis using X-ray diffraction. 4. inter atomic forces responsible for bonding in Solids.

Course Content		
Unit	Description	Weightage* (%)
1.	**Inverse square law field, potential and Motion in a central force field:** **Inverse Square Law – Field and Potential:** Introduction, Law of gravitational and electrostatic forces, Gravitational and electrostatic fields and potentials, Lines of force and equipotential surfaces, Fields and potentials of dipole and quadrupole, Field equations **Motion in a central Force Field:** Equivalent one body problem, Motion in a central force field, General features of the motion, Motion in an inverse square law force field, Equation of orbit, Kepler's laws of planetary motion. [Introduction to Classical Mechanics by R. G. Takwale and P. S. Puranik: 4.1, 4.2, 4.3, 4.4, 4.7,5.1, 5.2, 5.3, 5.4, 5.5 and 5.6]	25 %
2.	**Formulation of Schrödinger Equation:** **Quantum theory of radiation:** Introduction, Black body radiation, Wien's law, Rayleigh Jean's law**,** Planck's radiation formula, Compton Effect. **Towards Quantum Mechanics:** De Broglie's Hypothesis, The motion of a free wave packet: Classical approximation and uncertainty principle, Uncertainties introduced in the process of measurement, Approximate classical motion in slowly varying fields. **The Schrödinger Equation:** A free particle in one dimension, Generalization to three dimensions, The operator correspondence and the Schrödinger equation for a particle subject to forces. **Physical Interpretation and Condition on ψ:** Normalization and probability interpretation, Non-normalizable wave functions and box normalization, Conservation of probability, Expectation value and Ehrenfest's theorem, Admissibility conditions on the wave function.	25 %

	A Text Book of Quantum Mechanics by P. M. Mathews and K. Venkatesan (2nd Edition): 1.13, 1.14, 1.15,1.16, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7 ,2.8.]	
3.	**Crystal Physics:** Introduction, Lattice points and space lattice, The basics and crystal structure, Unit Cells and lattice parameters, Unit Cell versus Primitive Cell, Crystal systems, Crystal symmetry, The twenty three symmetry elements in a cubic crystal, Combination of symmetry elements, Rotation-inversion axis, Translation symmetry elements, Space groups, The Bravais space lattices, Metallic crystal structures (sc, bcc, fcc, hcp), Relation between the density of crystal material and lattice constant in a cubic lattice, Other cubic structures, Direction planes and Miller Indices, Important features of Miller indices of crystal planes, Important planes and directions in a cubic crystals, Separation between lattice planes in cubic crystal. [Solid State Physics by S. O. Pillai (7th Edition): Chapter-4, I, II, III, IV, V, VI, VII, VIII, X, XI, XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX, XX, XXII]	25 %
4.	**Interatomic Forces and Bonding in Solids:** **Interatomic Forces:** Introduction, Force between atoms, Cohesion of atoms and cohesive energy, Calculation of cohesive energy. **Bonding in Solids:** Bonding in solids, Ionic bonding, Bond energy of NaCl molecule, Calculation of lattice energy of ionic crystals, Calculation of Madelung constant of ionic crystals, Calculation of repulsive exponent from compressibility data, The Born-Haber cycle, Properties of ionic solids, Covalent bond, Saturation in covalent bond, Directional nature of covalent bond, Hybridization, Properties of covalent compounds, Metallic bond, Properties of metallic crystals, intermolecular bonds, Dispersion bonds, Dipole bonds, Hydrogen bonds, Van der Waals bonding, Atomic size, Ionic radii, Empirical ionic radii, variation of ionic radii, Covalent radii, Metallic radii, Van der Waals radii. [Solid State Physics by S. O. Pillai (7th Edition): Chapter-3, I, II, III, IV, V, VI, VII, VIII, IX, X, XI, XII, XIV, XV, XIV, XVII, XVII, XIX, XX, XXI, XXII, XXIII, XXIV, Solid State Physics by M. A. Wahab (2nd Edition): 2.11, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11]	25 %

Teaching-Learning Methodology	Direct Teaching – *Chalk & Duster technique* Interrogative sessions Teaching using Audio-Visual aids ICT enabled teaching Problem solving Seminar talks Learning through experiment and models Educational Tours

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the concepts of Gravitational & Electrostatic fields and potential. Get the knowledge of inverse square law in terms of motion of planetary objects.
2.	Familiar with the basic concepts of Quantum mechanics and formulation of Schrödinger equation.
3.	Understand the fundamental concepts and terms in crystallography.
4.	Accustomed with the basics of inter atomic forces and bonding in solids.

Suggested References:	
Sr. No.	References
1.	Introduction to Classical Mechanics R. G. Takwale and P. S. Puranik Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2.	Atomic Physics J. B. Rajam (Reprint 2002) S. Chand & Co. Ltd.
3.	A Text Book of Quantum Mechanics P. M. Mathews and K. Venkatesan (2^{nd} Edition) Tata McGraw Hill Publishing Co. Ltd., New Delhi.
4.	Solid State Physics S. O. Pillai (7^{th} Edition) New Age International Publisher
5.	Solid State Physics M. A. Wahab (2^{nd} Edition) Narosa Publishing House

On-line resources to be used if available as reference material
On-line Resources
https://www.wiziq.com/tutorials/classical-mechanics https://en.wikipedia.org/wiki/Quantum_mechanics#:~:text=Quantum%20mechanics%20is%20a%20fundamental,technology%2C%20and%20quantum%20information%20science. https://en.wikipedia.org/wiki/Introduction_to_quantum_mechanics https://en.wikipedia.org/wiki/X-ray_crystallography https://www.slideshare.net/yayavaram/crystal-structure-xray-diffraction http://web.eng.fiu.edu/wangc/EGN3365-2b.pdf

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Bachelor of Science
B.Sc. Physics Practical (Semester -IV)

Course Code	US04CPHY53	Title of the Course	Physics Practical
Total Credits of the Course	04	Hours per Week	08
Course Objectives:	The course aims at developing the following abilities in the learner: 1. acquire knowledge and develop understanding of concepts, fundamental laws, principles and processes in the area of physics so that relationship between cause and effects of physical phenomenon can be understood; 2. Experimental skills (like taking observations, manipulation of equipment) and communicative skills such as reporting of observations and experimental result. 3. problems solving ability e.g., analyzing a situation or data and ensure the justification of results. 4. Scientific temper of mind by making judgment on verified facts and not opinions, by showing willingness to accept new ideas and discoveries.		

Course Content		
	Description	Weightage* (%)
	Section A 1. Determination of 'g' by Kater's pendulum (variable distance) 2. Characteristics of FET 3. Study of a Hartley Oscillator 4. Study of a Colpitts Oscillator 5. Frequency Response of RC Coupled amplifier (with negative feedback) 6. Inductance L by Anderson's Bridge 7. Study of L-C-R parallel resonance circuit 8. Hybrid parameters of a BJT (CE configuration) 9. Verification of Stefan's law 10. Numerical Integration	50%

	Section B 1. Miller Indices using X-Ray diffraction pattern 2. de-Broglie Relation using electron diffraction pattern 3. Wave length of a monochromatic light 'λ' using double slit Method 4. Study of a Thermocouple 5. Wave length of a monochromatic light 'λ' using Lloyd's mirror 6. Cauchy's Constants 7. Absorption co-efficient of liquid using photocell 8. Identification of chemical elements using absorption spectra 9. To study double refraction in Calcite OR Quartz prism 10. Error analysis	50%

Note:

[1] To provide flexibility, up to the maximum of **20%** of total experiments can be replaced/added by college to this list prepared by the Board of Studies.

[2] A minimum of **Sixteen (16)** experiments must be performed in practical course.

[3] To maintain uniformity in assessment of practical examination the below mentioned marks distribution pattern is followed:

Sr. No.	Work done	Weightage as per 50 Marks
1.	Writing Principle / Statement/ Formula with explanation of symbols and units	08 Marks
2.	Diagram/Circuit Diagram / Expected Graph	08 Marks
3.	Setting up of the experiment + Tabular Columns + taking readings	14 Marks
4.	Calculations (explicitly shown) + Graph	10 Marks
5.	Accuracy of results with units	04 Marks
6.	Round the year Performance/ Records (to be valued at the time of practical Examination through oral viva)	06 Marks
	Total for Practical	**50 Marks**

Note:
Wherever explicit setting up of experiments does not exist like in the case of spectral charts or pre–acquired data is involved, the marks for setting up of experiment may be provided for additional graphs and formulae.

Teaching-Learning Methodology	Direct Teaching through Chalk-Walk and Talk ICT enabled teaching Question-Answer Laboratory/Panel discussion led by teacher/students Case Studies Problem solving activities Collaborative and Co-operative Learning Think Pair Share Project Based Learning Concept Mapping

Evaluation Pattern		
Sr. No.	Details of the Evaluation	Weightage
1.	Internal Written / Practical Examination (As per CBCS R.6.8.3)	15%
2.	Internal Continuous Assessment in the form of Practical, Viva-voce, Quizzes, Seminars, Assignments, Attendance (As per CBCS R.6.8.3)	15%
3.	University Examination	70%

Course Outcomes: On the successful completion of the course, the students will be able to	
	Apply the various procedures and techniques for the experiments.
	Use the different measuring devices and meters to record the data with precision
	Apply the mathematical concepts/equations to obtain quantitative results
	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.

Suggested References:	
Sr. No.	References
1.	Advanced Practical Physics for students B. L. Wosnop and H. T. Flint, Methuen and Co, Ltd., London.
2.	B. Sc. Practical Physics C. L. Arora, S. Chand & Co. Ltd., New Delhi.
3.	Advanced Practical Physics M. S. Chauhan and S. P. Singh, Pragati Prakashan, Meerut.
4.	Advanced Practical Physics S. L. Gupta and V. Kumar, Pragati Prakashan, Meerut.

On-line resources to be used if available as reference material
On-line Resources:
https://www.futurelearn.com/courses/teaching-practical-science-physics *****