IPS Academy, Institute of Engineering & Science

(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)

Bachelor of Technology (B.Tech.)

Minor Course

(To be offered to students of other departments)

S. No.	Subject Code	Semester	Subject Name	Contact Hours per week			Total Credits
				L	T	P	
1.		III	Quantum Mechanics	3	0	0	3
2.		IV	Electromagnetic Theory	3	0	0	3
3.		V	Laser Physics & Technology	3	0	0	3
4.		VI	Introduction to Solid State Physics	3	0	0	3
5.		VIII	Nuclear Physics	3	0	0	3
			Total	15	0	0	15

	Quantum Mechanics	3L:0T:0P (3 Hrs)	3 Credits

Pre-requisites: Introductory physics courses, including classical mechanics and Electromagnetism, Calculus.

Course Objectives: By the end of this course, students should be able to:
1. Understand the basic postulates of quantum mechanics.
2. Solve the Schrödinger equation for simple quantum systems.
3. Describe the wave function and its probabilistic interpretation.
4. Analyze quantum states and operators.
5. Calculate expectation values and probabilities for quantum measurements.
6. Apply quantum mechanics principles to various physical systems.
7. Develop strong analytical and problem-solving skills.

Course Content:

Module I: Basics of Quantum Physics
Origin of quantum theory; Failure of classical physics to explain the phenomena such as black body radiation, photoelectric effect, Compton effect and Dual nature of matter, Davisson and Germer's experiments, the concept of phase and group velocity, expectation values, physical interpretation and properties of wave functions, Heisenberg's uncertainty principle and its applications.

Module II: Schrodinger's Equation
Schrodinger equation; Energy and momentum operator, Schrodinger time dependent and independent wave equations in one dimensional and 3D problems.

Module III: Applications of Schrödinger Equation
Application of Schrödinger time independent equation; particle in box or potential well, Concept of tunneling; potential barrier, linear harmonic oscillator, hydrogen atom problem.

Module IV: Concept of Angular Momentum
General treatment of angular momentum, spin addition of angular momentum.

Module V: Approximation methods
Approximation methods; non degenerate and generate perturbation theory and variational methods.

.Textbooks/ References

1. L.L. Schiff, Quantum Mechanics, Mc Graw Hill Education.
2. A. Ghatak, Quantum mechanics, Trinity.
3. D.J. Griffiths, Introduction to quantum Mechanics, Cambridge University Press.
4. R.P Goyal, Unified Physics, Shiva Lal Agarwal & Company.
5. P.M. Mathew and K. Vankatesan, Quantum Mechanics, Mc Graw Hill Education.
6. A. Beiser, Concepts of Modern Physics, TMH.

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	Electromagnetic Theory	**3L:0T:0P (3 Hrs)**	**3 Credits**

Pre-requisites: Introductory physics courses covering mechanics and electromagnetism, Calculus.

Course Objectives: By the end of this course, students should be able to:

1. Understand and apply Maxwell's equations to describe electromagnetic phenomena.
2. Analyze and calculate electric and magnetic fields in various situations.
3. Comprehend the concept of electromagnetic waves and their properties.
4. Apply electrodynamics principles to practical situations in physics and engineering.

Course Content:

Module I: Electrostatics

Columbus law, Principle of superposition, electric field, electric flux, and line charged density, surface charge density, and volume charge density, Electric Field due to Point Charges, Electric Field due to Continuous Charge Distributions, Electric Potential and Potential Energy.

Module II: Scalar and vector field

Scalar and vector field; scalar field, vector field, Gradient of scalar field, Divergence of a vector field, physical significance of divergence, Gauss divergence theorem, curl of vector field, stokes theorem, Physical significance of curl.

Module III: Applications of Gauss's law

Gauss law; Gauss law for electric field in integral and differential form, applications of gauss law; field due to spherical shell of charge, field outside and isolated charge sphere, equipotential surfaces, electrostatic energy.

Module IV: Magneto statics

Equation of continuity; Biot-Savart law, Faraday's law of electromagnetic induction, Amperes law of magneto motive force.

Module V: Maxwell's equation

Maxwell's equation; Maxwell equation in differential and integral form, Maxwell equation in isotropic dielectric medium, Maxwell's equation in conducting medium, electromagnetic wave propagation, electromagnetic energy density, pointing vector and pointing theorem.

Textbooks/ References

1. D.J. Griffiths, Introduction to Electrodynamics, Cambridge University Press
2. J.D. Jackson, Classical electrodynamics, Wiley.
3. M. Purcell, electricity & magnetism, Berkeley Physics.
4. R.P Goyal, Unified Physics, Shiva Lal Agarwal & Company.
5. H.K. Malik & A.K. Singh, Engineering Physics, Mc Graw Hill Education.
6. J. Milfold & Christy, Foundation of electromagnetic theory, Pearson.
7. A.Z Capri &P.V. Panat, Introduction to electrodynamics, Alpha Science.

	Laser Physics and Technology	**3L:0T:0P (3 Hrs)**	**3 Credits**

Pre-requisites: Mathematics (Calculus), General Physics, Modern Physics.

Course Objectives: By the end of this course, students should be able to:
1. Understand the fundamental principles of laser operation.
2. Describe different types of lasers and their applications
3. Analyze the basic properties of laser light.
4. Discuss laser safety measures and regulations.

Course Content:

Module I: Introduction to Lasers

Historical overview, Properties of laser beams, Einstein's theory of matter radiation interaction and A and B coefficients, explain conditions to achieve lasing action, basic parts of a laser, principle of Laser, population inversion and gain medium.

Module II: Laser Oscillation and Amplification

Line shape function, Broadening of spectral lines: Lifetime broadening, Collision broadening, Inhomogeneous broadening, and threshold condition for oscillation, laser oscillation and amplification in a homogeneous broadened transition, gain saturation in a homogeneous broadened transition.

Module III: Types of Lasers

General Description, Laser Structure, Excitation Mechanism, Applications of; Ruby Laser, Neodymium YAG Laser, Helium–Neon Laser, Argon Ion Laser, Carbon Dioxide Laser, Excimer Lasers.

Module IV: Lasers Applications

Medical applications (surgery, eye surgery), Material processing (cutting, welding), Laser spectroscopy, Laser-based communication systems, Holography and imaging, LIDAR and remote sensing.

Module V: Laser Safety

Laser safety regulations and guidelines, Laser safety practices, protective measures and equipment Biological effects of laser exposure.

Textbooks/ References

1. William T. Silfvast, Laser Fundamentals, Cambridge
2. O. Svelto, Principles of Lasers, Springer.
3. Joseph T. Verdeyen, Laser Electronics, Third Edition, Prentice Hall.
4. K. Thyagarajan, Ajoy Ghatak, Lasers: Fundamentals and Applications, Springer Science and Business Media.
5. R. P. Goyal, Unified Physics, Shivlal Agarwala & Co.

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	Introduction to Solid State Physics	**3L:0T:0P (3 Hrs)**	**3 Credits**

Pre-requisites: General Physics, Calculus, Modern Physics.

Course Objectives: This course provides an introduction to the fundamental principles and concepts of solid-state physics. Students will explore the behavior of condensed matter systems, including crystal structures, electronic properties, and thermal properties. The course will also cover key topics in modern condensed matter physics, such as semiconductors, magnetism superconductivity and nano-materials.

Course Content:

Module I: Crystal structure and lattice types

Lattice points and space lattice, the basis and crystal structure, unit cell and lattice parameters, crystal systems, crystal symmetry; seven systems of crystals, types of lattices, coordination number, packing density, lattice planes and miller indices, reciprocal lattice, X-ray diffraction, Bragg's law.

Module II: Theory of Semiconductors and Superconductors

Free electron model, Kronig Penney model, Band theory of solids, density of states, Fermi Dirac distribution function, Fermi level in intrinsic and extrinsic semiconductor, charge carrier concentration and conductivity of intrinsic and extrinsic semiconductors, Hall Effect, Introduction to superconductivity, persistent currents, Meissner effect, Type-I and Type-II superconductors, BCS theory.

Module III: Nanomaterials

Overview of Nanomaterials, Nanoscale phenomena and properties, Historical perspective, Synthesis and Fabrication Techniques, Characterization technique of Nanomaterials, Applications in various fields.

Module IV: Magnetic properties of materials

Some terms related to magnetism; magnetic field, magnetic induction, magnetic permeability and susceptibility, classification of paramagnetic, diamagnetic and ferromagnetic substances, Langevin's theory of diamagnetism, Curie-Weiss law.

Module V: Thermal properties of solids

Introduction, specific heat, Classical theory (Dulong and Petit Law), Einstein's theory of specific heat, Debye's theory.

Textbooks/ References

1. C. Kittel, Introduction to solid state physics, Wiley
2. R. P. Goyal, Unified Physics, Shivlal Agarwal & Co.
3. S. O. Pillai, Solid state physics, New age international publisher
4. J. Carson, Introduction to Nanomaterials, States academic press
5. A. J. Dekker, Solid State Physics, Pan Macmillan

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	Nuclear Physics	**3L:0T:0P (3 Hrs)**	**3 Credits**

Pre-requisites: Introductory Physics, Quantum Mechanics

Course Objectives: By the end of this course, students should be able to:

1. Understand the fundamental properties and structure of atomic nuclei.
2. Analyze nuclear reactions and calculate cross-sections and reaction rates.
3. Describe nuclear models, such as the liquid drop model and the shell model.
4. Apply nuclear physics concepts to practical applications in nuclear medicine, and nuclear energy.

Course Content:

Module I: Introduction to Nuclear Physics

Structure of nuclei; nucleus size, spin nuclear magnetic moment, electric quadruple moment, atomic mass unit and binding energy, mass defect and packing fraction, The Deuteron problem Nuclear shapes and deformations.

Module II: Nuclear Models

Nuclear models; The liquid drop model, Shell model, Magic numbers Nuclear fission, Nuclear fusion, Chain reaction, Nuclear energy, Nuclear reactor

Module III: Particle Detectors

Nuclear Detectors; Ionization chamber, Proportional counter, GM Counter

Module IV: Particle Accelerators

Particle Accelerators; LINAC, Cyclotron, Synchrocyclotron, Betatron

Module V: Radioactive Decay

Alpha, Beta and Gamma Decay, Decay modes and half-life, Nuclear force, Nuclear Stability

Textbooks/ References

1. Cohen, Nuclear physics, Mc Graw Hill Publications
2. Shatendra K. Sharma, Atomic and Nuclear Physics, Pearson
3. N. Subrahmanyam, Brijlal, Atomic and Nuclear Phyics, S. Chand Publications
4. R.P Goyal, Unified Physics Shiva Lal Agarwal & Company
5. S.L. Kakani, Engineering Physics, CBS Publishers
6. Samuel Wong, Introductory of Nuclear Physics, Prentice Hall (1996)