UNDERGRADUATE COURSES

VISION, MISSION, PROGRAM SPECIFIC OUTCOMES, COURSE OBJECTIVES, COURSE OUTCOMES AND SYLLABI

DEPARTMENT OF PHYSICS
ALIGARH MUSLIM UNIVERSITY
ALIGARH (INDIA)
VISION

The department aims to excel and achieve a prominent status in Physics teaching and research.

MISSION

✔ To build a creative and stimulating environment conducive for teaching and research.
✔ To impart high quality Physics education and equip students for global Physics competence.
✔ To promote research and creative activities among faculty and students.
✔ To develop state of art facilities for teaching and research.
✔ To sensitise students to contribute for the welfare of society through competence in Physics.
B.Sc. (HONS.) Physics- PROGRAM SPECIFIC OUTCOMES (PSOs)

Upon completion of the undergraduate honours degree program in Physics at the Department of Physics, students will be able to:

1. demonstrate a proficiency in each core area of Physics namely Mechanics, Optics, Thermal Physics, Electricity and Magnetism, Electrodynamics, Electronics, Statistical Physics, Mathematical Physics, Computational Physics and Quantum mechanics.

2. demonstrate skill in using laboratory equipment, tools, materials and computer programming and software.

3. demonstrate both an understanding and the practical application of ethical standards as well as scientific temperament in public and private life.

4. demonstrate the ability to read, understand, and critically analyze the physical ideas presented in published textbooks and science magazines at the undergraduate level.

5. demonstrate the competence for Post Graduate Program in Physics and/or careers in scientifically oriented jobs in the public or private sector.
Syllabus with Course Objectives and Course Outcomes

B.Sc. (Hons.) I Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: MECHANICS
Course Number: PHB-152
Credits: 04
Type of course: Core (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)

Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
1. To develop basic understanding of fundamental mechanical concepts and principles including dynamics and properties of matters, non-inertial systems, central force motion, wave motion and special theory of relativity.
2. To apply mechanical concepts and principles to different mechanical processes and systems.

Course Outcomes
On completion of the course, students will be able to:
1. understand the concept of work and energy, elasticity, collision, viscosity, dynamics of rotational bodies, Coriolis force, non-inertial systems, central force motion, wave motion etc.
2. explain the concept of relativity, Lorentz transformations, length contraction, time-dilation.
3. apply the postulates of special theory of relativity to study relativistic transformation of velocity, variation of mass with velocity, massless particles and mass-energy equivalence.
Unit-I: Dynamics and Properties of Matters

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass (C.O.M.) and Motion of C.O.M.


Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Elasticity: Poisson ratio and determination of Poisson ratio of rubber, Relation between Elastic constants. Twisting torque on a Cylinder or wire.


Unit-II: Rotational Dynamics, Non-Inertial Systems and Central Force Motion


Unit-III: Oscillations and Waves

Oscillations: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Transient and steady states, Damped oscillation. Forced oscillations; Resonance, sharpness of resonance; power dissipation and Quality Factor.


Superposition of Two Harmonic Waves: Standing (Stationary) Waves. Changes of wave characteristics (displacement, particle velocity, pressure, phase, etc.) with respect to Position and Time. Phase and Group velocities and relation between them.

Unit-IV: Special Theory of Relativity

Reference Books:

- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

Additional Books for Reference:

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
Course Title: ELECTRICITY AND MAGNETISM-I
Course Number: PHB-252
Credits: 04
Type of course: Core (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)

Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To develop the understanding of the various concepts related to electrostatics, magnetostatics, electric circuits and networks and dielectric and magnetic properties of materials.

Course Outcomes
On completion of this course students will be able to:

1. apply Coulomb's law and Gauss' law for the electrostatic force.
2. explain the relationship between electrostatic field and electrostatic potential.
3. use the Lorentz force law for the magnetic force and solve the related problems.
4. use Ampere's law to calculate magnetic fields.
5. understand dielectric and magnetic properties of matter.
6. use various network theorems to solve complex electrical circuits.
Unit-I: Electric Field and Electric Potential

Unit-II: Magnetic Field
Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Definition of \( \mathbf{B} \), Properties of \( \mathbf{B} \): Curl and Divergence, Vector potential, Gauss’ law of magnetostatics Torque on a current loop in a uniform Magnetic Field, Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), magnetic moment and angular momentum. Ampere’s Circuital Law and its application to (1) Solenoid and (2) Toroid.

Unit-III: Dielectric & Magnetic Properties of Matter
Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitance of an isolated conductor. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector \( \mathbf{D} \). Relations between \( \mathbf{E} \), \( \mathbf{P} \) and \( \mathbf{D} \). Gauss’ Law in dielectrics.
Magnetic Properties of Matter: Three magnetic vectors \( \mathbf{B} \), \( \mathbf{M} \) and \( \mathbf{H} \) and relation among them. Magnetic Susceptibility and permeability, Gauss’s law of magnetostatics. Theory of magnetism (Qualitative idea), Curie-Weiss law of ferromagnetism, \( \mathbf{B-H} \) curves: hysteresis and demagnetization.

Unit-IV: Electrical Circuits and Network Theorems and Electromagnetic Waves
Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.
Reference Books:
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Electricity and Magnetism, Chattopadhyay, D. and Rakshit, P.C. (New Central Book Agency (P) Ltd.)
- Electricity and Magnetism, K. K. Tewari, S. Chand & Company Ltd.
Course Title: WAVES AND OPTICS  
Course Number: PHB-351  
Credits: 02  
Type of course: Core (Theory)  
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)  
Course Assessment:  
Internal assessment (1 Hour): 30%  
End Semester Examination (2.5 Hours): 70%  

Course Objectives  
Optics is one of the basic bones of physics and is at the heart of all modern imaging and communications technologies. This course provides students with an understanding of optical phenomena based on the wave description of light. The principles of polarization, interference and diffraction will be fully developed and optical devices that use these properties of light will be described.  

Course Outcomes  
On completion of the course, students will be able to:  
1. use the principles of wave motion and superposition to explain the physics of polarization, interference and diffraction.  
2. understand the idea of various kinds of polarization of light wave and their detection.  
3. get an idea of diffraction phenomenon and to study Fraunhofer and Fresnel diffraction.  
4. Apply the idea of spatial and temporal coherence for the formation of interference fringes as well as to study the formation of fringes of equal inclination and equal thickness.  
5. describe the operation of optical devices including, polarisers, retarders, and interferometers.
Syllabus for B.Sc.(Hons.) III Semester (Physics)
WAVES AND OPTICS
Paper Code: PHB-351

(Credits-02)
Theory:24 Lectures, Tutorial:04

Unit-I: Superposition of Harmonic Oscillations and Harmonic Waves
Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit-II: Polarization of electromagnetic waves

Unit-III: Interference
Interference: Division of amplitude and wavefront. Fresnel’s Biprism. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton’s Rings. Measurement of wavelength and refractive index.

Unit-IV: Diffraction
Fresnel Diffraction: Fresnel’s Half-Period Zones for Plane Wave. Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge.

Reference Books:
Syllabus with Course Objectives and Course Outcomes
B.Sc. (Hons.) III Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: ANALOG SYSTEMS AND APPLICATIONS
Course Number: PHB-353
Credits: 02
Type of course: Core (Theory)
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To empower students to understand the design and working of BJT, FETs, amplifiers, oscillators and Operational Amplifier.

Course Outcomes
On completion of the course, students will be able to:

1. understand the design and working of BJT and FETs and its biasing.
2. observe the performance of transistor amplifier under sinusoidal signal.
3. design RC coupled amplifier circuit using BJT and observe its amplitude and frequency response.
4. observe the effect of negative feedback on different parameters of an Amplifier
5. observe the effect of positive feedback and able to design different Oscillators
6. understand ideal and practical characteristics of operational amplifier and various applications of OP-AMP.
Syllabus for B.Sc.(Hons.) III Semester (Physics)
ANALOG SYSTEMS AND APPLICATIONS-I
Paper Code: PHB-353

Unit-I: Bipolar Junction Transistors and Amplifiers

Unit-II: Transistor Biasing and Feedback

Unit-III: RC Coupled Amplifiers, FET and Oscillators
RC-coupled amplifier and its frequency response.
Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, Hartley oscillators.

Unit-IV: Operational Amplifier and its Applications
Operational Amplifiers (Black Box approach). Characteristics of an Ideal and Practical Op-Amp. (IC 741). CMRR. Slew Rate and concept of Virtual ground.

Reference Books:
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
Course Title: **THERMAL PHYSICS**  
Course Number: **PHB-452**  
Credits: 02  
Type of course: Core (Theory)  
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)  
Course Assessment:  
Internal assessment (1 Hour): 30%  
End Semester Examination (2.5 Hours): 70%  

**Course Objectives**  
To develop comprehension of fundamental thermodynamic concepts and principles including behaviour of real and ideal gases, and to apply them to different thermodynamics processes and systems.

**Course Outcomes**  
On completion of the course, students will be able to:

1. apply the First law of Thermodynamics and calculate Heat, Internal Energy, Work in various thermodynamical processes and systems.

2. explain the concepts of Reversibility, Irreversibility, Carnot cycle, Entropy, Clausius theorem, Kelvin-Planck and Clausius statements of Second law of Thermodynamics, Thermodynamic potentials and Maxwell’s relations.

3. estimate the entropy changes in reversible and irreversible processes.

4. calculate the different measures of speeds in the Maxwell Boltzmann Distribution of velocities and derive the transport coefficients of Thermal conductivity, Viscosity and Diffusion in ideal gases.

5. describe the behaviour of real gases and obtain the critical constants of the gas.
Unit-I: Zeroth and First Law of Thermodynamics

Unit-II: Second Law of Thermodynamics

Unit-III: Kinetic Theory of Gases

Unit-IV: Real Gases

Reference Books:
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
- Classical and Quantum Thermal Physics, R. Prasad, 2016, Cambridge University Press
Course Title: **ELEMENTS OF MODERN PHYSICS**  
Course Number: **PHB-453**  
Credits: 02  
Type of course: Core (Theory)  
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)  
Course Assessment:  
Internal assessment (1 Hour): 30%  
End Semester Examination (2.5 Hours): 70%  

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**Course Objectives**  
To develop comprehension of fundamentals of Modern Physics and introductory course on Nuclear, Particle and Laser physics.  

**Course Outcomes**  
On completion of the course, students will be able to:  

1. understand de Broglie wavelength and dual nature of matter. Able to calculate problems related to dual nature and Heisenberg uncertainty principle.  
2. able to calculate eigen values for operators like momentum, energy etc.  
3. apply non-relativistic steady state Schrödinger’s equation’s for one dimensional problems related to infinite and finite potentials.  
4. estimate the structure of nucleus and apply the laws of radioactivity for alpha, beta and gamma decay.  
5. understand the basic features of particle interactions and apply the basic classification for elementary particles.  
6. calculate the Einstein’s A and B coefficient using semi-classical theory for lasers. Realization of three-level and four-level transitions in Ruby and He-Ne lasers.
Syllabus for B.Sc.(Hons.) IV Semester (Physics)
ELEMENTS OF MODERN PHYSICS – I 
Paper Code: PHB-453
(Credits-02)
Theory:24 Lectures, Tutorials:04

Unit-I: Quantum Mechanics-I
Blackbody Radiation: Planck's concept, Planck’s radiation formula; Quantum theory of light: Photo-electric effect and Compton scattering; De Broglie wavelength and matter waves; wave-particle duality, Heisenberg uncertainty principle and its applications.

Unit-II: Quantum Mechanics-II
Physical interpretation of wave function, probabilities and normalization; Schrodinger equation for non-relativistic particles (steady-state form); momentum and energy operators; stationary states; probability current densities in one dimension.
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization, idea of quantum mechanical tunneling.

Unit-III: Nuclear and Particle Physics
Nuclear Structure and Transformation: Size and structure of atomic nucleus; NZ graph, binding energy. Radioactivity: radioactive decay, mean life and half-life; idea of alpha decay; beta decay-energy released, gamma decay.
Particle physics: Particle interactions and their basic features, Leptons, Hadrons.

Unit-IV: Lasers
Lasers: Characteristics of laser beam, spontaneous and stimulated emissions, optical pumping and population inversion, Einstein’s A and B coefficients. Metastable states, three-level and four-level lasers (Qualitative); Ruby laser and He-Ne laser; Applications of lasers.

Reference Books:
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

Additional Books for Reference:
- Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore
Syllabus with Course Objectives and Course Outcomes
B.Sc. (Hons.) IV Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: **ELEMENTS OF MODERN PHYSICS**
Course Number: **PHB-491**
Credits: 02
Type of course: Open Elective (Theory)
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)

Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

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**Course Objectives**
To develop comprehension of fundamentals of Modern Physics and introductory course on Nuclear, Particle and Laser physics.

**Course Outcomes**
On completion of the course, students will be able to:

1. comprehend quantum nature of light and able to apply it on Compton scattering and pair production. Confirmation of de-Broglie hypothesis through Davisson-Germer experiment.
2. calculate the normalization of wave function and probability density.
3. apply non-relativistic steady state Schrödinger’s equation’s for one dimensional particle in a box and harmonic oscillator.
4. use semi-classical theory for lasers to understand stimulated and spontaneous emission and absorption and use it to obtain optical pumping and population inversion. Realization of three-level and four-level transitions in Ruby and He-Ne lasers.
5. apply the laws of radioactivity for alpha, beta and gamma decay and calculate half-life of radioactive nucleus.
6. understand the basic features of particle interactions and apply the basic classification for elementary particles based on different quantum numbers.
Syllabus for B.Sc.(Hons.) IV Semester (Physics)
ELEMENTS OF MODERN PHYSICS
Paper Code: PHB-491
(FOR STUDENTS OF OTHER MAINS)
(Credits-02)
Theory:24 Lectures, Tutorials:04

Unit-I: Particle and Waves

Unit-II: Quantum Mechanics
Wave Function, Normalization, Probability, Schrödinger’s equation, expectation value. Particle in a box. Harmonic oscillator.

Unit-III: Lasers

Unit-IV: Nuclear Physics and Elementary Particles
Nuclear Physics: Radioactive decay, half-life, radiometric dating, alpha decay, beta decay, gamma decay, nuclear fission, nuclear reactors, fusion reactors.
Elementary Particles: Interactions and particles, leptons, hadrons, elementary particle quantum numbers, quarks.

Reference Books:
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
Course Title: **MATHEMATICAL PHYSICS**
Course Number: **PHB-551**
Credits: **04**
Type of course: Core (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)

**Course Assessment:**
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

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**Course Objectives**
To develop required mathematical skills in the area of complex functions, special functions, integral transformations and vector calculus.

**Course Outcomes**
On completion of the course, students will be able to:

1. understand the complex variables and complex function and use it to calculate residue and definite integrals.
2. solve problems related with vector calculus with the help of differential operators like gradient, curl, divergence and Laplacian.
3. apply the Fourier series to expand the (arbitrary)periodic functions.
4. apply the integral transformations like Fourier and Laplace transformations to solve differential equations.
5. work with the special functions like Legendre, Hermite, Laguerre and Bessel function and solve the second order differential equation using Frobenius Method.
Syllabus for B.Sc.(Hons.) V Semester (Physics)

MATHEMATICAL PHYSICS

Paper Code: PHB-551

Credits-04

Theory:48 Lectures, Tutorials:08

(BOS: 21.05.18)

Unit-I: Complex Analysis

Unit-II: Vector Calculus and Orthogonal Curvilinear Coordinates


Unit-III: Fourier Series, and Integrals Transforms


Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Unit-IV: Frobenius Method and Special Functions

Reference Books:
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
Course Title: QUANTUM MECHANICS AND ITS APPLICATIONS
Course Number: PHB-552
Credits: 04
Type of course: Core (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To acquire basic understanding of the principles and applications of Quantum Mechanics and Quantum Computation.

Course Outcomes
On completion of the course, students will be able to:

1. show an understanding of the formalism of quantum mechanics and elementary features of Quantum Computation.

2. use the mathematical tools needed to solve quantum mechanics problems. This will include complex functions and Hilbert spaces, operators, wave functions and uncertainty relations. Methods to solve differential equations that arise in quantum mechanics using Frobenius method will also be studied.

3. solve the Schrödinger equation to obtain wave functions for some basic, physically important types of potential in one dimension, and estimate the shape of the wave functions.

4. solve Schrödinger equations in three dimensions using the technique of separation of variables to describe the structure of the hydrogen atom and evaluate quantization of angular momentum.

5. describe the differences between quantum and classical computation and demonstrate understanding of concepts of tensor products, entanglement, Bloch sphere, no cloning theorem and quantum gates in various representations.
Syllabus for B.Sc.(Hons.) V Semester (Physics)
QUANTUM MECHANICS AND APPLICATIONS
Paper Code: PHB-552

(Credits-04)
Theory:48 Lectures, Tutorials:08

Unit-I: Mathematical tools and Postulates of Quantum Mechanics
Hilbert Space, Wave functions and its properties, Operators, Hermitian, Unitary, Commutator Algebra, Eigenvalues and Eigen functions, Dirac Bra Ket Notation, Postulates of Quantum Mechanics, Observables and operators, Expectation Values, Time dependent Schrodinger equation, General solution in terms of linear combinations of stationary states, Application to spread of Gaussian wave-packet for a free particle in one dimension, wave packets.

Unit-II: Tunnelling, Finite Square Well Potential & Harmonic Oscillator
Tunnelling through Potential Step, Potential Barrier, Finite one-dimensional problem-square well potential, Bound state solutions, Solution of simple harmonic oscillator- Energy levels and Eigen functions using Frobenious method, Hermite polynomials; Ground state, Zero point energy

Unit-III: Quantum Theory of Hydrogen Atom
Time independent Schrodinger equation in spherical polar coordinates; Separation of variables for second order partial differential equation; Angular momentum operator and quantum numbers; Radial wave functions from Special function, Shapes of the probability densities for ground and first excited states, Concept of spin and Stern-Gerlach experiment

Unit-IV: Quantum Computation

Reference Books:
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
Course Title: **SOLID STATE PHYSICS**  
Course Number: **PHB-553**  
Credits: 02  
Type of course: Core (Theory)  
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)  
Course Assessment:  
Internal assessment (1 Hour): 30%  
End Semester Examination (2.5 Hours): 70%  

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**Course Objective**  
To convey an understanding of how solid state physics has contributed to the existence of a number of important technological developments. Students will also gain knowledge of basic theories of electronic structure and physical properties of solids.

**Course Outcomes**  
On completion of the course, students will be able to:  

1. understand the crystal structures through crystallographic parameters.  
2. differentiate between different types of matter depending on the nature of chemical bonds and their properties.  
3. learn the influence of lattice vibrations on the thermal behavior of solids.  
4. evaluate the electrical and optical properties of solids.  
5. understand the origin of energy bands, and describe theories of semiconductors.
Syllabus for B.Sc.(Hons.) V Semester (Physics)
SOLID STATE PHYSICS
Paper Code: PHB-553

(Credits-02)
Theory: 24 Lectures, Tutorials: 04

Unit-I Crystal Structure
Amorphous and crystalline materials; Concept of lattice, unit cell, Wigner-Seitz cell, Bravais lattices, Crystal planes and Miller indices, Interplanar spacing; Packing fraction for sc, bcc and fcc structures; Common crystal structures (NaCl and CsCl); Concept of reciprocal lattice, X-ray diffraction and Bragg’s law.

Unit-II Crystal bonding and Lattice Dynamics
Bonding in solids: Interatomic forces and cohesive energy; ionic, covalent, metallic, van der Waals’ and hydrogen bonds.
Elementary Lattice Dynamics: Lattice vibrations, linear one dimensional monatomic and diatomic chains, acoustical and optical branches; Dulong and Petit’s law, Einstein and Debye theories of specific heat of solids.

Unit- III Magnetic Properties of Materials and Superconductivity
Magnetic Properties: Dia-, para-, ferro-, antiferro- and ferrimagnetisms (qualitative only); Langevin classical theory of dia and paramagnetism; Weiss’s theory of ferromagnetism and ferromagnetic domains; hysteresis loop.
Superconductivity: Discovery of superconductivity, Meissner effect, Critical magnetic field, persistent current, penetration depth, type I and type II superconductors; idea of BCS theory.

Unit- IV Free electron and Band theories of Solids
Drude model: Electrical and thermal conductivities of metals, Hall effect: Hall coefficient and Applications; Failure of free electron theory; Band theory: Kronig Penny model, band structure of conductor, semiconductor (p and n type) and insulator.

References Books:
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publication
Syllabus with Course Objectives and Course Outcomes

B.Sc. (Hons.) V Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: **APPLIED OPTICS**
Course Number: **PHB-554**
Credits: 02
Type of course: Ability Enhancement Elective (Theory)
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To develop the basic understanding and concept of applied optics and to apply them in designing of various optical instruments and detectors such as laser, photodiodes, holograms, optical fiber and optical sensors

Course Outcomes
On completion of the course, students will be able to:

1. understand the basic concept of working of laser and optical detectors
2. explain the principle and theory of holography and types of holograms as well as its application in microscopy and interferometry.
3. get an idea of various parameters of optical fiber and their uses as sensors.
4. learn the concept of spatial frequency filtering and Fourier Transform Spectroscopy and its application in image processing.
Syllabus for B.Sc. (Hons.) V Semester (Physics)
APPLIED OPTICS
Paper Code: PHB-554

(BOS: 21.05.18)
(Credits-02)
Theory:24 Lectures, Tutorial:04

Unit-I: Sources and Detectors

Unit-II: Holography
Basic Principle and Theory: Coherence, Resolution, Recording and reconstruction processes of hologram, Types of holograms, White light reflection hologram, Application of holography in microscopy and interferometry.

Unit-III: Photonics

Unit-IV: Fourier Optics and Fourier Transform Spectroscopy
Fourier Optics: Concept of Spatial frequency filtering, Fourier transforming property of a thin lens.
Fourier Transform Spectroscopy: Representation of spectra, Basic elements of absorption and emission spectroscopy, Fourier Transform Spectroscopy (FTS) and its applications.

Reference Books:
Course Title: **DIGITAL SYSTEMS AND APPLICATIONS**
Course Number: **PHB-555**
Credits: 02
Type of course: Elective (Theory)
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)

Course Assessment:
- Internal assessment (1 Hour): 30%
- End Semester Examination (2.5 Hours): 70%

**Course Objectives**
To study CRO, analog and digital ICs, and to have the detail knowledge of combinational and sequential logic circuits and their applications.

**Course Outcomes**
On completion of the course, students will be able to:

1. understand about the CROs, analog and digital ICs and number conversion and their use.
2. study the boolean algebra and know the link between boolean algebra and logic gates.
3. study how the gates is used as a data processing circuit in combinational logic circuits.
4. study in detail about sequential logic circuit and their use as flip-flops, digital counters, shift registers and timer.
5. learn computer organization, microprocessor and assemble language and their use.
Unit-I: CRO, ICs and Digital Circuits


**Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Unit-II: Boolean algebra, Data processing circuits and Arithmetic Circuits


**Data processing circuits:** Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.


Unit-III: Sequential Circuits and Timers


**Shift registers:** Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

**Counters (4 bits):** Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

**Timers:** IC555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit-IV: Computer Organization, Microprocessor and Assembly Language


**Introduction to Assembly Language:** 1 byte, 2 byte & 3 byte instructions.
Reference Books:

Course Title: PHYSICS OF DEVICES AND INSTRUMENTS
Course Number: PHB-04
Type of course: Elective (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To develop comprehension of fundamental concepts of electronic devices and their applications.

Course Outcomes
On completion of the course, students will be able to:

1. learn about the transistors and other semiconductor devices, like MOS, MOSFET, CMOS etc.
2. explain the Power Supply, Integrated Circuit Regulators and various Filters.
3. learn the use of transistors as Multivibrators and to understand the basic principles of Phase Locked Loop, Loop Filter circuits, transient response and basic idea of PLL IC.
4. understand the basic process for IC fabrication, Oxide layer, Oxidation technique for Si and Metallization technique.
5. understand the Serial Communications and details of USB, GPIB and basic idea of sending data through a COM port.
6. develop the idea of Communication Systems. Block diagram, Amplitude modulation/demodulation, Phase, Pulse.
Syllabus for B.Sc.(Hons.) V Semester (Physics)

PHYSICS OF DEVICES AND INSTRUMENTS

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial: 08

Unit-I: Devices and Power supply

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection, Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

Unit-II: Multivibrators and Phase Locked Loop
Multivibrators: Astable and Monostable Multivibrators using transistors.

Phase Locked Loop (PLL): Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Unit-III: Processing of Devices and Digital Data Communication Standards


Unit-IV: Communication systems
Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. Basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Reference Books:
- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
Course Title: **NUCLEAR AND PARTICLE PHYSICS**

Course Number: **PHB-557**

Credits: 04

Type of course: Elective (Theory)

Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)

Course Assessment:
- Internal assessment (1 Hour): 30%
- End Semester Examination (2.5 Hours): 70%

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**Course Objectives**

1. To develop basic understanding of fundamental concepts of properties of nuclei, radioactive decay and interaction of nuclear radiation with matter.

2. To understand various types of particles and their properties, basic interactions, conservation laws, concepts of spin and parity of particles, resonance particles and quark model.

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**Course Outcomes**

On completion of the course, students will be able to:

1. understand the concept of nuclear structure, radioactive decay and interaction of nuclear radiation with matter.

2. detect nuclear radiations using gas filled detectors, G.M counter, ionization chamber, scintillation detectors, semi-Conductor (SC) detectors and sensitive gas filled detectors.

3. explain the nature of interaction and their mediating quanta, conservation laws.

4. apply basic interactions to understand types of particles and its families, idea of resonances, spins and parity of pions, concept of Quark model.
Syllabus for B.Sc. (Hons.) V Semester (Physics)
NUCLEAR AND PARTICLE PHYSICS
Paper Code: PHB-557

(Credits-04)
Theory:48 Lectures Tutorials:08

Unit I: General properties of nuclei: Constituent of nucleus and their intrinsic properties, size of the nucleus, radii, charge density. Nuclear charge: measurement of nuclear charge, Alpha scattering methods, nuclear mass, measurement of mass using Bainbridge spectrograph, mass defect, binding energy, variation of binding energy with atomic mass number. Elementary idea of nuclear fusion-fission, nuclear angular momentum, nuclear magnetic dipole moment, nuclear electric quadrupole moment: definition, units, significance of positive and negative values.

Nuclear reactions:- Types of reaction, conservation laws, Q-value: negative Q-value reaction and threshold energies, energetic of α, β⁺, β⁻ and electron capture (EC) decay.

Unit 3: Interaction of nuclear radiation with matter:- Energy loss due to ionization (Bethe block formula), range and straggling, Cerenkov radiation, interaction of Gamma radiation with matter, Photoelectric effect, Compton scattering and Pair production.

Unit IV: Particle Physics:- Basic interactions and their mediating quanta, types of particles and its families, Fermions and Bosons, Leptons and Hadrons, particles and antiparticles, idea of resonances, conservation rules in fundamental interactions. Determination of spins and parity of pions, spins of particles, associated production, strangeness and decay mode, charge kaons, Isospin and its conservation, Concept of Quark model: Quarks their quantum numbers.

Reference Books:
- Kenneth S. Krane : Introductory nuclearPhysics by (Wiley India Pvt. 2008)
- D. Griffith : Introductory to Elementary Particles (Jhon Wiley & Sons)
- Enge, H. A. : Introductory to nuclear Physics (Addison Wesely)
- Evans, R. D. : Atomic Nucleus (Macgraw Hill)
- Kapoor, S. S. & Ramamurthy, V. S. : Nuclear Radiation Detectors (New Age)
- Knoll, G. F. : Radiation Detectors
- Dodd, J. E. : Ideas of Particles Physics (Cambridge Univ. Press.)
- Martin, B. R & Shaw, R. G. : Ghoshal,: Particle Physics (John Wiley)
- S. N. : Atomic and Nuclear Physics (S. Chand & Company, Ltd)
Course Title: **CLASSICAL MECHANICS AND E.M. THEORY**
Course Number: **PHB-651**
Credits: 04
Type of course: Core (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

**Course Objectives**
To develop mathematical concepts and skills among the students regarding the Lagrangian and Hamiltonian formulations of mechanical systems, E.M. theory and its applications.

**Course Outcomes**
On completion of the course, students will be able to:

1. express the Lagrangian and Hamiltonian and solve problems based on of various classical systems
2. understand and solve central force and Kepler’s problems.
3. achieve an understanding of Maxwell’s equation, gauge transformation and boundary conditions between different media.
4. manipulate and apply Maxwell’s equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
5. analyse the phenomena of wave propagation in unbounded, bounded, vacuum, dielectric and guided and unguided media.
6. calculate the reflection and transmission coefficient at plane interface in bounded media.
7. know the features of planar, optical and rectangular wave guides and obtain the field components, Eigen value equation and energy flow, phase and group velocities in the dielectric media.
8. understand the fundamentals of propagation of electromagnetic waves through optical fibres and calculate numerical aperture for step and graded indices, etc.
(BOS: 21.05.18)

Syllabus for B.Sc.(Hons.) VI Semester (Physics)
CLASSICAL MECHANICS AND ELECTROMAGNETIC THEORY
Paper Code: PHB-651

(Credits-04)
Theory:48 Lectures, Tutorial:08

Unit-I: Lagrangian Dynamics and Variational Principles
Constraints -- holonomic and non-holonomic, time independent and time dependent. Generalized coordinates, Lagrange equations from D'Alembert’s principle, velocity dependent potentials, velocity dependent potential for e.m. field, applications of Lagrangian formalism to simple mechanical systems. Variational principle: Technique of the calculus of variation, Hamilton’s variational principle, Lagrange equations using Hamilton’s principle. Generalised momenta, cyclic coordinates, Definition of energy function and Hamiltonian and its physical significance, conservation of energy, conservation of linear and angular momenta.

Unit-II: Hamiltonian Dynamics and Two-body Central Force Problems
Hamilton’s equation of motion from variational principle, Conservation laws and cyclic coordinates, Hamiltonian as a constant of motion, Two-body problem: Central force problem, conservation of angular momentum and Kepler’s second law, the Kepler problem - inverse square law of force, Kepler’s first and third laws, the Virial theorem and its simple applications. Two-body collisions - Scattering by a central force, Rutherford scattering formula, transformation of the scattering problem from centre of mass to laboratory coordinates.

Unit-III: Maxwell Equations and EM Waves

EM Wave Propagation in Unbounded Media: Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, Metallic reflection (normal Incidence)

Unit-IV: Wave Guides and Optical Fibres
Wave Guides: Planar optical wave guides. Waves in hollow conductors. T.E. and T.M. modes. Rectangular wave guides (TE and TM cases)
**Reference Books:**

- Classical Mechanics, H. Goldstein, 3rd Ed. (Paperback), 2011, Pearson Education
- Classical Dynamics of Particles Systems Marion, S. T. Thornton, and J. B. Marion, 5th Ed., 2003, Brooks Cole
- Introduction to Electrodynamics, D.J. Griffiths, 4th Ed., 2015, Pearson Education India Learning Private Limited
Course Title: **STATISTICAL MECHANICS**  
Course Number: **PHB-652**  
Credits: 02  
Type of course: Core (Theory)  
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)  
Course Assessment:  
- Internal assessment (1 Hour): 30%  
- End Semester Examination (2.5 Hours): 70%  

### Course Objectives

This course intends to develop understanding regarding the basic concepts of classical and quantum statistical mechanics and its application to Classical and Quantum Theory of Radiation, and Bose and Fermi Statistics.

### Course Outcomes

On completion of the course, the student should be able to:


2. differentiate between Classical and Quantum Theory of Radiation and derive the properties of black body radiation from the classical and quantum perspective.

3. derive the B-E distribution law and apply it for a strongly Degenerate Bose Gas, Bose Einstein condensation(qualitative description), properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas.


5. solve problems relevant to above topics.
Unit-I: Classical Statistics

Unit-II: Classical and Quantum Theory of Radiation


Unit-III: Bose-Einstein Statistics
B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation(qualitative description), properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas.

Unit-IV: Fermi-Dirac Statistics

Reference Books:
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
- Statistical Physics, L. D. Landau and E. M. Lifshitz, 3rd Ed, Elsevier
Syllabus with Course Objectives and Course Outcomes
B.Sc. (Hons.) VI Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: **BASIC INSTRUMENTATION SKILLS**
Course Number: **PHB-653**
Credits: 02
Type of course: Ability Enhancement (Theory)
Contact Hours: 2 Lectures per week (Total: 24 Lectures and 04 Tutorials)
Course Assessment:
- Internal assessment (1 Hour): 30%
- End Semester Examination (2.5 Hours): 70%

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**Course Objective**
To impart knowledge of design, operation and use of various electrical and electronic instruments in real life applications and paraphrase their importance.

**Course Outcomes**
On completion of this course students will be able to:

1. familiarize and analyze the signal accordance to accuracy, precision, sensitivity, resolution, errors etc.
2. use and measure frequency, phase etc. of the signal with CRO.
3. acquire purpose, scope and concepts of signal generator and wave analyzer.
4. understand different types of bridges and their construction to find unknown values.
5. develop an understanding of construction and working of different analog and digital devices.
Syllabus for B.Sc.(Hons.) VI Semester (Physics)
BASIC INSTRUMENTATION SKILLS
Paper Code: PHB-653

(Credits-02)
Theory:24 Lectures, Tutorial:04

Unit-I: Instruments for Electrical Measurement
Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC millivoltmeter: Type of AC millivoltmeters: Amplifier-rectifier, and rectifier-amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Unit-II: Cathode Ray Oscilloscope
Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Unit-III: Signal Generators and Analysis Instruments
Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q-Meter. Digital LCR bridges.

Unit-IV: Digital Instruments

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:
1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges
Laboratory Exercises:
1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.

Open Ended Experiments:
1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:
- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India 65

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Course Title: **ATOMIC, MOLECULAR AND LASER PHYSICS**
Course Number: **PHB-654**
Credits: 04
Type of course: Elective (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
- Internal assessment (1 Hour): 30%
- End Semester Examination (2.5 Hours): 70%

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**Course Objectives**
To develop the theoretical and experimental knowledge of various types of atomic/molecular spectra and Lasers as well as the basic techniques of experimental spectroscopy.

**Course Outcomes**
On completion of the course, students will be able to:

1. know the theoretical and experimental background of atomic as well as molecular spectra.
2. understand various types of Lasers, their working and applications.
3. understand basic components of spectroscopic instruments and their functions.
4. know about measurements of atomic/molecular spectra using spectrometers.
Syllabus for B.Sc.(Hons.) VI Semester (Physics)
ATOMIC, MOLECULAR AND LASER PHYSICS
Paper Code: PHB-654
(Credit-04)
Theory: 48 Lectures, Tutorials: 08

Unit-I: Atomic Physics
One valence electron atom: Electronic configuration and atomic states, spin-orbit interaction, fine structure, intensity rules for structure doublets, selection rule for electrical dipole transitions. Two valence electron atoms: LS and jj coupling scheme, vector model of atom, terms and levels for non-equivalent electron system (sp, pd and spd configuration) and equivalent electrons (p², d² configurations). Hund’s rules. Normal and anomalous Zeeman effect. Hyperfine structure.

Unit-II: Molecular Physics
Rotational Spectra: Diatomic molecule as rigid and non-rigid rotator, effect of isotopic substitution, rotational spectrum.
Raman Spectra: Classical and quantum theory of Raman effect, polarizibility, rotational Raman spectra of diatomic molecules. Vibrational Raman spectra.

Unit-III: Laser Physics
Spontaneous and stimulated emissions, population inversion, Resonator: modes of resonator, number of modes per unit volume, open resonator, quality factor, Laser pumping, ammonia maser, principal and working of Argon ion, CO₂ laser, and N₂lasers. Characteristics of laser beam.
Holography: Recording of hologram, reconstruction of image, characteristics of holographs.

Unit-IV: Experimental Spectroscopy

Reference Books:
- Introduction to Atomic Spectra, White, H.E. (McGraw-Hill)
- Atomic and Quantum Physics, Haken, H. & Wolf, H.C.,
- Haken, H. & Wolf, H.C., Atomic and Quantum Physics (Springer-Verlag)
- Hollas, J.M., Basic Atomic and Molecular Spectroscopy(R.S.C)
- Laud, B.B. Lasers and Non-Linear Optics (Wiley Eastern)
- Wolfgang Demtröder, Atoms, Molecules and Photons
• Sawyer, R.A., Experimental Spectroscopy (Dover)
• Thorne, A., Litzen, U, Johansson, S. Spectrophysics (Springer)
Syllabus with Course Objectives and Course Outcomes
B.Sc. (Hons.) VI Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: **NANOMATERIALS AND APPLICATIONS**
Course Number: **PHB-655**
Credits: 04
Type of course: Elective (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
- Internal assessment (1 Hour): 30%
- End Semester Examination (2.5 Hours): 70%

**Course Objectives**
To develop the basic concept of nanoscience and acquire an understanding of various characterization techniques and potential applications of nanomaterials.

**Course Outcomes**
Upon completion of this course students will be able to:

1. understand the classification of nanostructures and effects of quantum confinement on the electronic structure of nanomaterials.
2. comprehend the behavior of nanostructures in quantum mechanical approach
3. identify the different ways of nanomaterials synthesis and their characterization techniques.
4. gain knowledge of basic theories of electron transport and optical properties of nanomaterials.
5. provide understanding of MEMS/NEMS applications specially sensors, Micro machining tools etc.
6. familiarize about the potential applications of nanomaterials in LEDs, solar cells, MEMS/NEMS etc.
Syllabus for B.Sc.(Hons.) VI Semester (Physics)
NANO MATERIALS AND APPLICATIONS
Paper Code: PHB-655

(Credits-04)
Theory:48 Lectures, Tutorials:08

Unit-I: Nanoscale Systems
Physical length scales in nanostructures, 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size effects in smaller systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in nanostructures and its consequences.

Unit-II: Synthesis and Characterization of Nanostructure Materials
Synthesis: Top down and Bottom up approach, High energy ball milling, Sol-gel method, Spin coating, Electrodeposition, Thermal evaporation, E-beam evaporation, Pulsed laser deposition (PLD). Chemical vapor deposition (CVD).

Unit-III: Electron Transport and Optical Properties
Electrical Transport: Various conduction mechanisms in low dimensional systems: Thermionic emission, Schottky effect, Poole-Frankel effect, Variable range hopping conduction and Polaron conduction.

Unit-IV: Applications
Applications of quantum dots for light emitting diodes (LEDs) and solar cells, Single electron transistors (no derivation), CNTs based field effect transistors, Nanomaterial Devices: Quantum dots heterostructure lasers, Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS), Molecular switches.

Reference Books:
- CP. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
Syllabus with Course Objectives and Course Outcomes
B.Sc. (Hons.) VI Semester (Physics)
Department of Physics
Aligarh Muslim University, Aligarh

Course Title: CLASSICAL DYNAMICS
Course Number: PHB-656
Credits: 04
Type of course: Elective (Theory)
Contact Hours: 4 Lectures per week (Total: 48 Lectures and 08 Tutorials)
Course Assessment:
Internal assessment (1 Hour): 30%
End Semester Examination (2.5 Hours): 70%

Course Objectives
To develop basic understanding of the fundamentals of Classical Mechanics and Electrodynamics.

Course Outcomes
On completion of this course students will be able to:

1. express the equations of motion for complicated mechanical systems using the Lagrangian, Hamiltonian and canonical transformation formulations of classical mechanics
2. demonstrate an understanding of the basic principles of the special theory of relativity and perform basic calculations in relativistic kinematics and dynamics in four vector formalism.
3. master the technique of deriving and evaluating formulae for the electromagnetic fields from very general charge and current distributions.
4. calculate the electromagnetic radiation from localised charges which move arbitrarily in time and space, taking into account retardation effects and account for the underlying approximations and assumptions.
5. describe the nature of electromagnetic wave and its propagation through different media and interfaces.
Syllabus for B.Sc.(Hons.) VI Semester (Physics)
CLASSICAL DYNAMICS
Paper Code: PHB-656
(Credits-04)
Theory:48 Lectures, Tutorial:08

Unit-I:

Unit-II: Special Theory of Relativity-I

Unit-III: Special Theory of Relativity-II
The Electromagnetic field tensor and its transformation under Lorentz transformations: relation to known transformation properties of $E$ and $B$. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields.

Unit-IV: Electromagnetic Radiation and Wave Guides

Reference Books:
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.