NED UNIVERSITY OF ENGINEERING & TECHNOLOGY
E-Mail:dracad@neduet.edu.pk/Website:http://www.neduet.edu.pk
Phone: (92-21) 99261261-8 Ext-2221/Fax: (92-21) 99261255

No.Acad/34(82)/5554 **Dated: 06-06-2023**

NOTIFICATION

It is hereby notified that the University Syndicate vide its Resolution No. SYN-205.6(iv) dated 26-05-2023 has approved change in degree title of BS (Applied Physics) to BS (Physics) for Department of Physics, applicable from Batch-2023, as under:

Scheme of Studies- Bachelor of Science (Physics) (BSPH)

FIRST-YEAR

Fall Semester					Spring Semester				
		Credit Hours					Credit Hours		
Course Code	**Course Title**	**Th**	**Pr**	**Total**	**Course Code**	**Course Title**	**Th**	**Pr**	**Total**
PH-101	Mechanics and Properties of Matter	**3**	**0**	**3**	PH-104	Waves and Oscillations	**2**	**0**	**2**
PH-102	Heat and Thermodynamics	**2**	**0**	**2**	PH-105	Electricity and magnetism	**3**	**0**	**3**
PH-103	Physics Lab-I	**0**	**1**	**1**	PH-106	Physics Lab-II	**0**	**1**	**1**
HS-105 OR HS-127	Pakistan Studies OR Pakistan Studies (For Foreigners)	**2**	**0**	**2**	CY-122	General Chemistry	**2**	**1**	**3**
CT-174	Fundamentals of Information Technology	**2**	**1**	**3**	MT-227	Differential Equations	**3**	**0**	**3**
MT-173	Calculus	**3**	**0**	**3**	CT-175	Programming Fundamentals	**3**	**1**	**4**
HS-104	Functional English	**3**	**0**	**3**	HS-205 OR HS-209	Islamic Studies OR Ethical Behavior (For Non-Muslims)	**2**	**0**	**2**
MT-100	Introduction to Mathematics (For Pre-Medical students)	**-**	**-**	**NC**					
	Total	**15**	**2**	**17**		**Total**	**15**	**3**	**18**

SECOND YEAR

Fall Semester					Spring Semester				
		Credit Hours					Credit Hours		
Course Code	**Course Title**	**Th**	**Pr**	**Total**	**Course Code**	**Course Title**	**Th**	**Pr**	**Total**
PH-207	Optics and Laser	**3**	**0**	**3**	PH-205	Classical Mechanics	**3**	**0**	**3**
PH-202	Modern Physics	**3**	**0**	**3**	PH-204	Introduction to Material Science	**3**	**0**	**3**
MT-272	Linear Algebra & Geometry	**3**	**0**	**3**	PH-203	Physics Lab-III	**0**	**1**	**1**
EL-232	Electronics	**3**	**1**	**4**	MT-331	Probability and Statistics	**3**	**0**	**3**
CT-262	Introduction to Artificial Intelligence	**2**	**1**	**3**	HS-214	Academic Writing	**3**	**0**	**3**
					EL-238	Digital Electronics	**3**	**1**	**4**
					HS-200	Community Service	**-**	**-**	**NC**
	Total	**14**	**2**	**16**		**Total**	**15**	**2**	**17**

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THIRD YEAR									
Fall Semester					**Spring Semester**				
		Credit Hours					**Credit Hours**		
Course Code	**Course Title**	**Th**	**Pr**	**Total**	**Course Code**	**Course Title**	**Th**	**Pr**	**Total**
PH-301	Quantum Mechanics-I	**3**	**0**	**3**	PH-307	Mathematical Physics-II	**3**	**0**	**3**
PH-303	Mathematical Physics-I	**3**	**0**	**3**	PH-309	Electromagnetic Theory-II	**3**	**0**	**3**
PH-304	Electromagnetic Theory-I	**3**	**0**	**3**	PH-311	Physics Lab-V	**0**	**1**	**1**
PH-310	Solid State Physics-I	**3**	**0**	**3**	PH-403	Solid State Physics-II	**3**	**0**	**3**
PH-206	Physics Lab-IV	**0**	**1**	**1**	PH-415	Statistical Mechanics	**2**	**0**	**2**
HS-301	Business and Organizational Communication	**3**	**0**	**3**	MG-110	Fundamentals of Management	**2**	**0**	**2**
					HS-###	Foreign Language-I	**-**	**-**	**NC**
	Total	**15**	**1**	**16**		**Total**	**13**	**1**	**14**

FOURTH-YEAR									
Fall Semester					**Spring Semester**				
		Credit Hours					**Credit Hours**		
Course Code	**Course Title**	**Th**	**Pr**	**Total**	**Course Code**	**Course Title**	**Th**	**Pr**	**Total**
PH-308	Quantum Mechanics-II	**3**	**0**	**3**	PH-407	Physics Project	**0**	**3**	**3**
PH-312	Physics Lab-VI	**0**	**1**	**1**	##-###	Elective-II	**3**	**0**	**3**
PH-407	Physics Project	**0**	**3**	**3**	##-###	Elective-III	**3**	**0**	**3**
PH-409	Atomic and Molecular Physics	**2**	**0**	**2**	##-###	Elective-IV	**3**	**0**	**3**
PH-417	Nuclear Physics	**2**	**0**	**2**	MG-481	Entrepreneurship	**3**	**0**	**3**
PH-418	Computational Physics	**3**	**0**	**3**					
##-###	Elective-I	**3**	**0**	**3**					
HS-###	Foreign Language-II	**-**	**-**	**NC**					
	Total	**13**	**4**	**17**		**Total**	**12**	**3**	**15**
						Grand Total			**130**

List of Elective Courses- Bachelor of Science (Physics) (BSPH)

S. No	Course Code	Title	Cr Hr. Theory	Cr Hr. Practical	Cr Hr. Total
1	PH-313	Cosmology and Theory of Relativity	3	0	3
2	PH-411	Applications of Space Physics	3	0	3
3	PH-413	Surface Sciences	3	0	3
4	PH-416	Space Physics	3	0	3
5	PH-419	Fundamentals of Medical Physics	3	0	3
6	PH-420	Nano Science and Nanotechnology	3	0	3
7	PH-421	Vacuum Science	3	0	3
8	PH-422	Plasma Physics	3	0	3
9	EL-333	Integrated Circuits	3	0	3
10	EL-484	Optoelectronics and Microwave Systems	3	0	3
11	MY-402	Advance Materials	3	0	3

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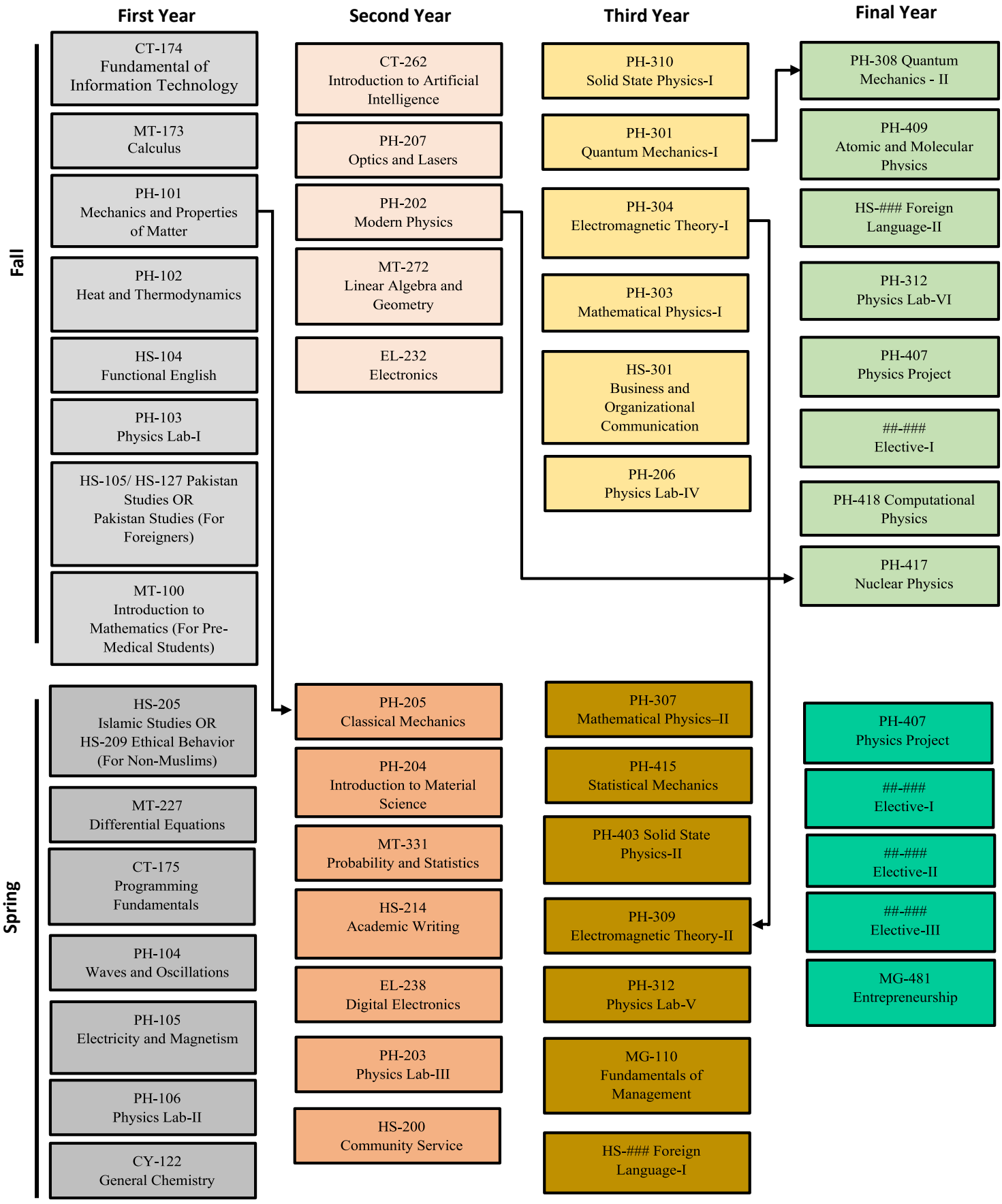
Course Dependency Chart of Proposed Scheme of Studies



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NEW COURSES

PH-207 Optics and Laser			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Propagation of Light and Image Formation: Huygens' Principle, Fermat's Principle, Laws of Reflection and Refraction, Refraction at a Spherical Surface Thin Lenses, Newtonian Equation for a Thin Lens.
Matrix Methods in Paraxial Optics: Ray Transfer Matrices, Thick Lens, Significance of System Matrix Elements, Cardinal Points, optical instruments, Chromatic and Monochromatic Aberrations.
Superposition and Interference: Standing Waves, Beats, Phase and Group Velocities, Two-Beam and Multiple Beam Interference, Thin Dielectric Films, Michelson and Fabry-Perot Interferometers, Resolving Power, Free-Spectral Range.
Polarization: Linear, circular and elliptical polarization, Jones Matrices, Production of Polarized Light, Dichroism, Brewster's Law, Birefringence, Double Refraction, Electro-optic and magneto-optic effects.
Diffraction: Fraunhofer Diffraction from a Single Slit, Rectangular and Circular Apertures, Double Slit, Many Slits, Diffraction Grating, Dispersion, Resolving Power Blazed Gratings, Zone Plates, Rectangular Apertures.
Coherence and Holography: Temporal Coherence, Spatial Coherence, Holography of a Point object and Extended Objects.
Laser: Population Inversion, Resonators, Threshold, and Gain Energy Quantization in Light and Matter, Thermal Equilibrium and Blackbody Radiation, Non-laser Sources of Electromagnetic Radiation, Einstein's Theory of Light-Matter Interaction, Elements, operation, Characteristics, types and Parameters of Laser, Rate Equations Absorption, Gain Media, Steady-State Laser Output, Homogeneous Broadening, Inhomogeneous Broadening, Time-Dependent Phenomena.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. See Leang Chin, Huailiang Xu ,Shuai Yuan, "*Fundamentals of Laser Optoelectronics*", 2nd edition, WSPC, 2022.
2. C. A. Bennett, "*Principles of Physical Optics*", 2nd edition, John Wiley, 2022

Reference Book(s)

1. Prem B. Bisht, "*An Introduction to Photonics and Laser Physics with Applications*", IOP, 2022.

PH-418 Computational Physics			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Computer languages: A brief Introduction to computer languages and known software packages of computation.
Errors: Error analysis and technique for elimination of systematic and random errors, determination of relative true error and relative approximate error in numerical methods.
Numerical Methods: Bracketing and open methods to find root of equation, solution of linear algebraic equations, regression and interpolation, Newton's divided-difference and Lagrange interpolation technique, the trapezoidal and Simpson's rules for numerical integration, differentiation, numerical methods for solutions of ordinary differential equation (ODE).
Modeling & Simulations: Conceptual models, the mathematical models, Random numbers and random walk, Doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation.
Modeling of Physical Systems: Motion of falling objects, projectile motion, oscillatory motion, planetary motion, many particle systems, dynamic systems, wave phenomena, Field of static charges and current, Diffusion, Populations genetics.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Sujaul Chowdhury, "*Computational Physics",* American Academic Press, 2021.
2. Omair Zubairi, Fridolin Weber, "*Introduction to Computational Physics for Undergraduates",* IOP, 2018.
3. Steven C. Chapra; Raymond P. Canale, "Numerical Methods for Engineers" 8th edition, McGraw Hill. 2021

Reference Book(s)

1. Clough, David E, Steven C. Chapra, "*Introduction to Engineering and Scientific Computing with Python*", CRC Press, 2022.

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PH-419 Fundamentals of Medical Physics			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Basic Terminologies: Historical Review, Radiobiology, Role of Medical Physicist and Medical Technologists in current medical facilities.

Radiation-related Units: Radiation Exposure, Radiation dose, the Radiation dose to different mediums, Kinetic Energy Released Per Unit Mass (KERMA), Radiation Quality and Quantity.

Radioactivity and Radiation-related Instruments: Radioactivity, Half-life, Radioactive radiation sources, X-Ray, Linear Accelerator, Cobalt 60 (Co 60), Brachytherapy, Nuclear Medicine, Computed Tomography (CT) scan, Magnetic Resonance Imaging (MRI), Dose measurement, Ionization Chambers, Dose measurement instruments.

Biological Effects of Radiation: Harmful effects of radiation, Radiation protection, As Low As Reasonably Achievable (ALARA) principle, Rem, Sievert, Dose Equivalent, Effective dose equivalent.

Radiation Measurement Instrument: Exposure limits for the public and workers, Radiation exposure monitoring devices, Film badges, Pocket dosimeters, and Thermo-Luminescent Dosimeters (TLDs).

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. D.R. Dance S. Christofides, "*Diagnostic Radiology Physics A Handbook for Teachers and Students*", IAEA, 2014**.**
2. Stephen Frederick Keevil, Cornelius Lewis, Anthony Greener, "*Introduction to Medical Physics*", 1st edition, CRC Press, 2022.

Reference Book(s)

1. Debbie Peet, Emma Chung, "*Practical Medical Physics: A Guide to the Work of Hospital*", 1st edition, CRC Press, 2021.

PH-420 Nano Science and Nanotechnology			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Introduction: Feynman talks on small structures, Nano scale dimension,

Surfaces and Interfaces: Interfaces, Surface chemistry and physics, Surface modification, Thin Films, Sputtering, Self-assembled films. Single-walled and multi-walled carbon nanotubes, and their applications.

Material Properties: Subatomic physics to chemical systems, types of chemical bonds.

Synthesis Nano Materials: Top-Down and Bottom-Up approaches, Sol-gel, Hydrothermal and other methods, Lithography (photo and electron beam), MBE, Self-assembly, FIB, Stamp technology, Nano junctions.

Characterization Techniques:

Electron Microscopy (STM, AFM, SEM and TEM), Fluorescence methods, Synchrotron Radiation, XRD, VSM.

Electrons in Nano Structures: Single electron transistor, Resonant tunneling,

Molecular Electronics: Lewis structures, Approach to calculate Molecular orbitals, Electron transfer between molecules, single molecule electronics.

Nano Materials: Quantum dots, nano wires, nano photonics, magnetic nano structures, nano thermal devices, Nano fluidic devices, biomimetic materials, DNA micro-arrays, Protein and DNA Assembly.

Nanotechnology Innovations: Nanostructure innovation, Quantum Informatics, Energy solutions.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Massimo F. Bertino, "*Introduction to Nanotechnology*", WSPC, 2022.
2. Chris Binns, "*Introduction to Nanoscience and Nanotechnology*", 2nd edition, Wiley, 2021.

Reference Book(s)

1. Deb Newberry, "*Nanotechnology Past and Present",* Morgan & Claypool Publishers, 2020.

PH-421 Vacuum Science			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Vacuum Science: Importance of vacuum, Pressure and molecular density, Adsorption, Desorption, Diffusion and Permeation, Gas-Solid Interactions, Flow Regime, Conductance, Vacuum Pump Technologies, and its parameters, detecting leaks in vacuum systems, Valves and Seals for high and ultra-high vacuum, Gas Load, Effects of humidity on vacuum system performance, Outgassing, Surface finishes for vacuum applications, Calculations of ultimate base pressure of a vacuum system.

Vacuum Systems: Chamber Design, Materials for Vacuum, Vacuum Pumps for High and Ultra-High Vacuum Applications Pressure regimes, Types of vacuum pumps and pumping technologies, Wet vs Dry pumps, Pumping speed, Pump throughput, Rotary Vane Pumps, Dry scroll pumps, Diaphragm pumps, Cryo Pumps, Turbomolecular pumps and hybrids, Diffusion pumps, Ion Pumps. Titanium sublimation pumps, Non-Evaporable Getter (NEG) Pumps, Vacuum Gauging and systems, detection of Leaks in Vacuum Systems, Residual Gas Analyzers and Partial Pressure Analyzers.

Applications of Vacuum: Thin film deposition technologies, Thin Film Growth Models, Effects of Deposition Conditions on Film Characteristics, Enhanced Deposition Techniques, Atomic Layer Deposition (ALD), Thin film growth models, Enhanced Reactivity of Precursors and Carrier Gases, Alternative Pulse Regimes, Impact of the ALD Process on Balance-of-Plant and its applications, Sealing techniques and system components, Actuation mechanisms, Configurations, Fine control gas admission systems, Mass flow controllers.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Pramod K. Naik, "*Vacuum: Science, Technology and Applications*", 1st edition, CRC Press, 2020.
2. J.R. Gaines, Matthew Healy, "*Fundamentals of Vacuum Science and System Design for High and Ultra-High Vacuum*", 1st edition, Elsevier, 2023.

Reference Book(s)

1. Donald M. Mattox, "*The Foundations of Vacuum Coating Technology"*, 2nd edition, William Andrew, 2018.

PH-422 Plasma Physics			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Introduction to Plasma: Occurrences of plasma in nature, Plasma conditions, Plasma Confinement, Debye shielding, Criteria for plasma.

Characteristic Parameters of Plasma: Number density and temperature, Debye length, plasma frequency, cyclotron frequency, Collision frequency, number of electrons per Debye cube, de-Broglie wavelength, quantum effects.

Single Particle Motion Model: Uniform and non-uniform electric and magnetic field, Time varying electric and magnetic fields, Adiabatic invariants.

Plasma Fluid Model: Fluid equation of motion, convection derivative, Stress tensor, collision, comparison with ordinary hydrodynamics, equation of continuity, equation of state.

Controlled Fusion: Introduction to controlled fusion, Basic nuclear fusion reaction, Reaction rates and power density, Radiation losses from plasma, Operational conditions.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Richard Fitzpatrick, "*Plasma Physics: An Introduction*", 2nd edition, CRC Press, 2022.
2. Francis F. Chen, "*Introduction to Plasma Physics and Controlled Fusion*", 3rd edition, Springer, 2016
3. Donald A. Gurnett, Amitava Bhattacharjee, "*Introduction to Plasma Physics: With Space, Laboratory and Astrophysical Applications*", 2nd edition, Cambridge University Press, 2017

Reference Book(s)

1. Gianpiero Colonna, Antonio D'Angola, "*Plasma Modeling: Methods and applications*", IOP Publishing Ltd, 2016.

REVISED COURSES

PH-101 Mechanics and Properties of Matter			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Vectors: *Review of Vector Analysis, Gradient, Divergence, and Curl.*
Motion in one and two dimensions: Motion in one- and two-dimensions, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion Inertial and Non-Inertial Reference Frames.
Newton's Law: Newton's Laws of Motion and their applications, *Time-dependent forces*.
Newton's Law and Related Planetary Laws of Motion: Newton law of Gravitation, Kepler's Laws, Escape Velocity, and their applications.
Work and Energy: Work done by Constant and Variable Forces *Work-Energy theorem*, Power, Conservative and Nonconservative Forces.
System of Particles: Newton's Laws for a System of Particles, Conservation of Linear Momentum, Impulse, Momentum and Kinetic Energy in One- and Two-Dimensional Elastic and Inelastic Collisions.
Rotational Motion: Rotation about a Fixed Axis, *Dynamics of rotatory bodies*, *Angular Motion*, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Angular Momentum for a System of Particles, Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes, effects of Torque.
Properties of Matter: Elastic Properties of Matter, Poisson's ratio, the Relation between three types of elasticity, Fluid Statics, Variation of Pressure in fluid at rest and with height in the atmosphere, Coefficient of viscosity, fluid flow through a cylindrical pipe (Poiseuille's law).

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. David Halliday, Robert Resnick, Jearl Walker, "*Fundamentals of Physics, Extended*" 12th edition, Wiley, 2021.
2. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019.

Reference Book(s)

1. Christina Earley, "*Properties of Matter*", Seahorse Publishing, 2022.Alauddin Khan, "*Properties of Matter, Waves, and Oscillations. An Introduction to Basic Mechanics",* 1st edition, GRIN Verlag, 2021.

PH-104 Waves and Oscillations			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	2	2	100
Pr	0	0	0

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation, LC and LCR Circuit, Simple Pendulum, Quality Factor, Steady-State Behavior, Driven LCR Circuit.
Forced Damped Harmonic Oscillation: Transient Oscillator Response, Resonance.
Coupled Oscillation: Spring-Coupled Masses, Coupled LC Circuits, Normal Modes, Atomic and Lattice Vibrations.
Transverse Waves: Transverse Standing Waves, General Time Evolution of a Uniform String, Phase velocity, and Group Velocity.
Longitudinal Waves: Spring Coupled Masses, Waves in an Elastic Solid.
Sound and Acoustics: Sound Waves in an Ideal Gas, *Doppler Effect and its application*.
Standing and Travelling waves: Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Transmission Lines, Reflection, and Transmission at Boundaries, Fourier series and Fourier Transforms, Bandwidth, Plane Waves, Three-Dimensional Wave Equations, Electromagnetic waves, Laws of Geometric Optics, and Cylindrical Waves, Interference of waves by slits diffraction.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. A. P. French, "*Vibrations and Waves*", CBS, 2017.
2. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019.

Reference Book(s)

1. P Alauddin Khan, "*Properties of Matter, Waves, and Oscillations. An Introduction to Basic Mechanics"*, 1st edition, GRIN Verlag, 2021
2. Joel Franklin, "*Mathematical Methods for Oscillations and Waves*", 1st edition, Cambridge University Press, 2020.

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PH-105 Electricity and Magnetism			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Electrostatic: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge, a Charge Distribution and Electric Dipole Electric Flux, Gauss' Law and its Applications.
Electric Potential: Potential due to a Point Charge, Electric Dipole and continuous charge distributions. The Relation between Electric Field and Electric Potential Energy.
Capacitor and Capacitance: Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in Capacitors.
DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, EMF source, Resistances in Series and Parallel, Single and Multiloop Circuits, *Circuit analysis rules and theorem,* RC Circuits, Charging and Discharging of Capacitor.
Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Magnetic Force on a Current-Carrying Wire, Torque on a Current Loop, Biot-Savart Law and its application, Ampere's Law, and its applications.
Electromagnetic Induction: Inductance, Faraday's Law of Induction, Lenz's Law, Self-Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.
Alternating Fields and Currents: Alternating Currents *Circuit theory, Resonant circuits*, Power in AC Circuits, Transformers, *AC Bridges.*
Magnetism and Magnetic Material: Magnetic induction, magnetization, diamagnetism, Para-magnetism, Ferromagnetism, *The Electron theory of magnetism*, and the Hysteresis curve.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. D.L. Sehgal, K.L. Chopra ,N.K. Sehgal, "*Electricity and Magnetism*", 2020 edition, Sultan Chand & Sons, 2020.
2. P. F. Kelly, "*Electricity and Magnetism*", 1st edition, CRC Press, 2021.
3. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th edition, Pearson, 2019.

Reference Book(s)

1. V. K. Sachan, "*Electricity and Magnetism*", KDP Print, 2020.

PH-202 Modern Physics			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Wave-Particle Duality: The consequences of black body radiation, Stefan Boltzmann, Wien's, and Planck's law, The quantization of energy, Photoelectric and Compton effect, Line spectra, quantum theory, de-Broglie hypothesis and its testing, Davisson Germier Experiment and J.P. Thomson Experiment, Wave behavior of particles and relation to the probability of particle, Wave packets, and particles, localizing a wave in space and time.
Atomic Physics: Bohr's theory, Frank-Hertz experiment, energy levels of electrons, atomic spectrum, Angular momentum of electrons, Vector atom model, Orbital angular momentum, Spin quantization, Bohr's Magnetron, X-ray spectrum (continuous and discrete) Moseley's law, Pauli's exclusion principle, and its use in developing the periodic table.
Basic Concepts of Radioactivity: *Laws of Radioactivity, Half-Life, types of decay.*
Special Theory of Relativity: *Einstein's Postulates of special relativity and their consequences, The Lorentz transformation, Transformation of relativistic momentum, and energy.*

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. R. A. Freedman, H. D. Young, and A. L. Ford, "*University Physics with Modern Physics*", 15th ed. Pearson, 2019.
2. Kenneth S. Krane, "*Modern Physics*" 4th edition, Wiley, 2019.

Reference Book(s)

1. John C. Morrison, "*Modern Physics with Modern Computational Methods: for Scientists and Engineers*", 3rd edition, Academic Press, 2020.
2. Raymond Serway, Clement Moses ,Curt Moyer, "*Modern Physics"*, 6th edition, W. H. Freeman, 2012.

PH-205 Classical Mechanics

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr	0	0	0

Linear Motion: The Law of Conservation of Energy, *motion under a constant force*, *motions under variable force*, Energy, The Calculus of Variations, Hamilton's principle.

Central Conservative Forces: Reduced mass, Conservation theorems, *first integral of the Motion*, *Equation of Motion*, Orbits in a central field, *Centrifugal Energy and Effective Potential*, Planetary Motion, *Orbital Dynamics*.

Rotating Frames: Angular Velocity, Particle in a Uniform Magnetic Field, Apparent Gravity, Coriolis Force, Larmor Effect.

The Two-Body Problem: Centre of mass and Relative Co-ordinates, The Centre of mass Frame, Elastic Collisions, CM and Lab Cross-sections.

Many-Body Systems: Center of mass, linear momentum, Angular Momentum, Central Internal Forces, elastic collision of two particles kinematics of elastic collision, inelastic collision, Scattering Cross-sections, Mean Free Path, Rutherford Scattering.

Rigid Bodies: Basic Principles, Rotation about an Axis, Perpendicular Components of Angular Momentum, Principal Axes of Inertia, Calculation of Moments of Inertia, Effect of a Small Force on the Axis, Instantaneous Angular Velocity, Rotation about a Principal Axis, Euler's Angles.

Lagrangian Mechanics: Generalized Co-ordinates, Holonomic Systems, Lagrange's Equations, Precession of a Symmetric Top, Pendulum Constrained to Rotate about an Axis, Charged Particle in an Electromagnetic Field, The Stretched String.

Small Oscillations and Normal Modes: Introduction to Oscillatory Motion, Simple Harmonic Oscillator, Harmonic Oscillations in two-dimensions, Phase Diagrams, General Case of Coupled Oscillations, Eigenvectors and Eigenfunctions, Normal Co-ordinates, Small Oscillations of Particles on String.

Hamiltonian Mechanics: Hamilton's Equations, Conservation of Energy, Ignorable Co-ordinates, General Motion of the Symmetric Top, Liouville's Theorem, Symmetries and Conservation Laws, Galilean Transformations.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s):

1. Stephen T. Thornton, Jerry B. Marion, "*Classical Dynamics of Particles and Systems*", 6th edition, Cengage Learning, 2022.
2. T. M. Helliwell, V. V. Sahakian, "*Modern Classical Mechanics*", 1st edition, Cambridge University Press, 2021.

Reference Book(s)

1. T. L. Chow, "Classical Mechanics", 2nd edition, Wiley, 2013.

PH-204 Introduction to Material Science

	Cr. Hrs.	Contact Hrs.	Exam Marks
Th.	3	3	100
Pr	0	0	0

Structure of Crystalline Solids: The packing of atoms in 2-D and 3-D, unit cells of the hexagonal close packing (hcp) and cubic closed packing (ccp) structures, interstitial structures, density computation, lattices, and symmetry elements, indexing lattice directions and lattice planes, interplanar spacing, lattices and crystal systems in 3-D, symmetry, crystallographic point groups, and space groups.

X-ray diffraction: *Generation of X-rays*, Bragg's law and the intensities of Bragg reflections, *Laue's Equation, X-rays diffraction methods, The Laue's Method, Rotating Crystal Method, Powder Method, Reciprocal Lattice, Imperfections in Solids*.

Mechanical properties of solids: *Types of stress and strain and its yield estimations*, elastic deformation, plastic deformation, Young's modulus, shear modulus, Poisson's ratio, elastic strain energy, thermal expansion, Dislocations, and Strengthening Mechanisms, fracture mechanics, ductile fracture, brittle fracture, Griffith criterion, ductile fracture, the toughness of engineering materials, the ductile-brittle transition temperature, cyclic stresses and fatigue, creep.

Structure of Polymer: Polymer basics, polymer identification, polymer molecules, additional polymerization, step growth polymerization, measurement of molecular weight, thermosetting polymers and gels, rubbers and rubber elasticity, configuration and conformation of polymers, the glassy state and glass transition, determination of T_g effect of temperature and time, mechanical properties of polymers, case studies in polymer selection and processing, materials selection, biopolymers, structural polysaccharides, hard materials, biomedical materials.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. W. D. Callister, D. G. Rethwisch "*Fundamentals of Materials Science and Engineering: An Integrated Approach*", Wiley, 5th edition, 2018.

Reference Book(s)

1. Yip-wah Chung, Monica Kapoor, "*Introduction to Materials Science and Engineering*", 2nd edition, CRC Press, 2022.

PH-301 Quantum Mechanics-I			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Review of Basic Concepts: *Young's double-slit experiment,* de-Broglie's hypothesis, wave-particle duality, *statistical in the interpretation of matter waves, probability density,* wave packets.
Mathematical Foundation: *Linear vector space, Hilbert space* and wave function, quantum operators, Linear operators, and their properties, Eigen values, Eigen Functions, Dirac notation, expectation values, Hermitian operators and their properties, Commutator algebra, Heisenberg uncertainty principle and superposition, Heisenberg and wave mechanics.
Postulates of Quantum Mechanics *Basic postulates of quantum mechanics,* the state of the system, observable and operators, *the time evolution of the system state, time development of state function,* expectation values, and conservation laws, Stationary state, *time-dependent and independent Schrodinger equation.*
Applications of The Quantum Postulates: Bound and unbound states**,** free particle, transmission and reflection at a step, barrier penetration (tunneling), infinite and finite potential well (up to 3D), the harmonic oscillator (up to 3D), solving the Eigenvalues of the harmonic oscillators by the polynomial method, central potential, angular momentum, *Eigen functions of angular momentum, eigenvalues of orbital angular momentum, operators L_2 and L_z, spherical harmonics. Stern Gerlach experiment, symmetry principles,* Pauli spin matrices, spin angular momentum.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Nouredine Zettili, "*Quantum mechanics: concept and application*", 3rd edition, Wiley, 2022.
2. Richard L Liboff, "*Introductory Quantum Mechanics*", 4th edition, Addison-Wesley, 2022.

Reference Book(s)
1. John Dirk Walecka, "*Introduction to Quantum Mechanics*", World Scientific Publication, 2022.

PH-304 Electromagnetic Theory-I			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

The Dirac Delta Function: Review of Vector Calculus, *Curvilinear Co-ordinates,* The Dirac Delta Function, vector calculus using the example of Dirac Delta function.
Electrostatic: *Coulomb's Law, electric field, divergence and curl of the electric field, electric potential, work, and energy in electrostatic, conductors.*
Potential: *Poisson's equation*, Laplace's equation in one, two, and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems, the method of images, multipole expansion.
Electric Field in Matter: Polarization, dielectrics, the field of the polarized object, bound charges with physical interpretation, electric displacement, Gauss's law in the presence of dielectrics, and linear dielectrics.
Magnetostatics: Lorentz force law, Biot-Savart Law and its application, the divergence and curl of the magnetic field, Ampere's law *and its application* magnetic vector potential, boundary condition, multipole expansion off vector potential.
Magnetic Field in the Matter: Magnetization, diamagnets, paramagnets, ferromagnets, torques, and forces on magnetic dipoles, the field of the magnetized object, bound current with physical interpretation, auxiliary field H, Ampere's law in magnetized materials, linear and non-linear media, magnetic susceptibility and permeability.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.
2. Matthew N.O. Sadiku, "*Elements of Electromagnetics*", 7th edition, Oxford University Press, 2018.

Reference Book(s)
1. A. B. Bhattacharya, Atanu Nag, "*Physics: Introduction to Electromagnetic Theory*", 1st edition, Khanna Publishing House, 2021.

Contd…. Page-11

PH-310 Solid State Physics-I			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Diffraction of X-rays through Crystal: *Crystal structure*, Diffraction of X-rays from periodic structures; *Geometrical form* of Bragg's law, Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis.

Lattice Vibration: Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Mono-atomic and diatomic basis, Optical Properties in the Infrared Region, Lattice heat Capacity.

Free Electron Theory of Metals: Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes, Classical free electron theory of metals, energy levels and density of orbitals in one dimension, effect of temperature on the Fermi–Dirac distribution function, properties of the free electron gas.

Application of Free Electron Theory of Metals: electrical conductivity and Ohm's Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with applications.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. M.A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
2. Siegfried Hunklinger, Christian Enss, "*Solid State Physics",* De Gruyter, 2022.

Reference Book(s)

1. E. Fred Schubert, "*Physical Foundations of Solid-State Devices*", 2022.

PH-308 Quantum Mechanics-II			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

One Electron System: *The Schrodinger equation in Spherical co-ordinates, central potential, separation of variable, radial equation, hydrogen wave function.*

Addition of Angular Momenta: Total angular momentum in quantum mechanics, the addition of two arbitrary angular momenta, Clebsch-Gordon coefficients, coupling of orbital and spring angular momenta.

Approximation methods in Quantum Mechanics: Time-independent perturbation theory for non-degenerate and degenerate levels, the variational method, the WKB approximation, Application of the approximation methods to simple cases, time-dependent perturbation theory, linear and non-linear response of a two-level system subjected to a sinusoidal perturbation.

Identical Particles: Indistinguishability of identical particles, systems of identical particles, quantum dynamics of identical particle systems, statistics, symmetry of states, fermions, bosons.

Basics of Quantum Computing: *Quantum bits, Bell states, Bloch sphere, Quantum gates.*

Theory of Scattering: Scattering experiments and cross sections, potential scattering, the method of partial waves, the Bornn's approximation.

Recommended book(s) for the approved course

(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Nouredine Zettili, "*Quantum mechanics: concept and application*", 3rd edition, Wiley, 2022.
2. Bernhardt, Chris., "*Quantum computing for everyone*", MIT Press, 2019.

Reference Book(s)

1. Richard L Liboff, "*Introductory Quantum Mechanics*", 4th edition, Addison-Wesley, 2022.

PH-309 Electromagnetic Theory-II			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Electrodynamics: Electromotive force, Ohm's law, motional emf, electromagnetic induction, Faraday's law, inductance, energy in magnetic fields, Maxwell's correction in Ampere's Law, and Maxwell's equations with boundary conditions.
Conservation Law: The continuity equation, Charge conservation, Poynting's theorem and energy conservation, Newton's third law in electrodynamics, Maxwell's stress tensor, Conservation of momentum, angular momentum.
Waveguide: *Basic concepts of waves*, the wave equation, reflection, and transmission, polarization, electromagnetic waves in vacuum, matter, and conductors, the frequency dependence of permittivity, waveguides, *types of waveguides* the coaxial transmission line.
Radiation: Dipole Radiation, the basis of the radiation reaction.
Potential and Fields: *Scalar and vector, Potentials, Gauge transformations, Lorentz force law, and potential form.*
Relativistic Electrodynamics: Relativistic Electrodynamics, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.
2. Pierluigi Zotto, Massimo Nigro, "*Problems in General Physics Electromagnetism*", Società Editrice Esculapio, 2022.

Reference Book(s)
1. A. B. Bhattacharya, Atanu Nag, "*Physics: Introduction to Electromagnetic Theory*", 1st edition, Khanna Publishing House, 2021.

PH-415 Statistical Mechanics			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	2	2	100
Pr	0	0	0

Review of Classical Thermodynamics: Thermodynamic processes (engines, refrigerators), and phase equilibria.
Foundation of Statistical Mechanics: Phase Space, Trajectories in Phase Space, *Specification of the state of a system, Macro and micro states,* Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities.
Statistical Ensembles: The concept of ensembles, Statistical, Microcanonical, canonical and grand ensemble**),** calculation of mean values, equipartition theorem and examples (ideal gas, harmonic oscillator), calculation of partition function and its relation with thermodynamic quantities**,** *total Partition function.*
Simple Applications of Ensemble Theory: Monoatomic ideal gas in the classical and quantum limit, Gibb's paradox and**,** *Entropy*, the specific heat of solids, quantum mechanical calculation of Para magnetism.
Classical and Quantum Statistics: *Relative population of two states Maxwell-Boltzmann (MB) distribution function Bose-Einstein (BE) distribution, Fermi-Dirac (FD) distribution,* quantum mechanical enumeration of states, polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE), Systems of Interacting Particles, ferromagnets in mean field approximation.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Jean Bricmont, "*Making Sense of Statistical Mechanics*", 1st edition, Springer, 2022.
2. Luca Salasnich, "*Modern Physics: Introduction to Statistical Mechanics*", 1st edition, Springer, 2022.

Reference Book(s)
1. Osvaldo Civitarese, Manuel Gadella, "*Methods in Statistical Mechanics: A Modern View*", 1st edition, Springer, 2020.
2. James P. Sethna, "*Statistical Mechanics: Entropy, Order Parameters, and Complexity*", 2nd edition, Oxford University Press, 2021.

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PH-103 Physics Lab-I			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments on Mechanics, Heat and Thermodynamics will be conducted, *encompassing topics namely, the Young's modulus, modulus of rigidity, acceleration due to gravity, pendulum, surface tension, moment of inertia, viscosity, specific heat, thermal conductivity, thermal coefficient and thermocouple*.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Laboratory Workbook for Physics Lab-I

Reference Book(s)
1. C.L. Arora, "*B.Sc. Practical Physics*", S Chand & Co Ltd, 2010.
2. Robert Lucas, "*Physics Virtual Laboratory*", CRC Press, 2022.

PH-106 Physics Lab-II			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments on Waves, Oscillation, Electricity and Magnetism will be conducted, *encompassing topics namely, the components of magnetic fields, hysteresis curve, frequency responses of the series and parallel LCR circuits, linear density, unknown high resistance, capacities and current sensitivity, harmonic motion and travelling waves.*

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Laboratory Workbook for Physics Lab-II.

Reference Book(s)
1. C.L. Arora, "*B.Sc. Practical Physics*", S Chand & Co Ltd, 2010.
2. Ronald Laymon, Allan Franklin, "*Case Studies in Experimental Physics*", 1st edition, Springer, 2022.

PH-203 Physics Lab-III			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments in Optics, *Laser*, Modern, Physics *Classical Mechanics, and material science* will be conducted, *encompassing topics namely, the Newton's rings, diffraction grating, refractive index, resolving power, inverse-square Law, photoelectric effect, ionization energy, divergence of laser beam, alignment of laser, Lissajous curve, projectile motion, optical activity of a substance*.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Laboratory Workbook for Physics Lab-III.

Reference Book(s)
1. Ronald Laymon, Allan Franklin, "*Case Studies in Experimental Physics*", 1st edition, Springer, 2022.
2. Robert Lucas, "*Physics Virtual Laboratory*", CRC Press, 2022.

PH-206 Physics Lab-IV			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments in electromagnetism, and solid-state physics, *Quantum Physics* will be conducted, *encompassing topics namely, the solar cell, band gap analysis, resonators, fine structures, energy conversion analysis and Michelson interferometer for the study of magnetic properties.*

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)
1. Laboratory Workbook for Physics Lab-IV.

Reference Book(s)
1. M.A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
2. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.

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PH-311 Physics Lab-V			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments in Solid State Physics, electromagnetism and *Mathematical Physics* will be conducted, *encompassing topics namely, the X-ray diffraction, crystal structures of crystalline materials, dielectric properties of the material and different analysis of Hall effect, ODE solution.*

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Laboratory Workbook for Physics Lab-V

Reference Book(s)

1. M.A. Wahab, "*Solid State Physics: Structure and Properties of Materials*",3rd edition, Narosa Publishing House, 2021.
2. David J. Griffiths, "*Introduction to Electrodynamics*", 4th edition, Cambridge University Press, 2017.

PH-312 Physics Lab-VI			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	0	0	0
Pr	1	3	50

Experiments in *Atomic and Molecular Physics, Nuclear Physics, and Computational Physics* will be conducted, *encompassing topics namely, concept of discrete energy level, radioactive decay process, numerical method related to root finding, integration, ODE solution, comparison of Poisson and Gaussian distribution.*

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Laboratory Workbook for Physics Lab-VI.

Reference Book(s)

1. Raymond Serway, Clement Moses ,Curt Moyer, "*Modern Physics",* 6th edition, W. H. Freeman, 2012.
2. Clough, David E, Steven C. Chapra, "*Introduction to Engineering and Scientific Computing with Python*", CRC Press, 2022.

PH-313 Cosmology and Theory of Relativity			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Theory of relativity: Galilean Relativity, the Concept of ether, the Michelson-Morely Experiment, Einstein's Postulates of Special Theory of Relativity, Lorentz Transformations, Minkowskian geometry of space-time, Four-dimensional space-time, Light-cone, the relativity of simultaneity, Time dilation, Length contraction, Mass variation, Twin paradox, Velocity transformation and velocity addition, Relativistic Mechanics, the variational principle for free particle motion, light rays, Principles of General Theory of Relativity, The curved space-time of general relativity, metric co-ordinate transformations, Equation of geodesics.

Cosmology: Einstein's field Equation, Cosmology Newtonian Cosmology, Hubble's Law, *locally inertial and Riemann normal co-ordinates,* Expansion of the Universe, Cosmic Microwave Background Radiation, and Big Bang model of the Universe, *Big Bang vs Inflation.*

Tensor Applications: *Tests of general relativity models, black holes, cosmological models.*

Introduction of Space Science: Introduction of Space Science Introduction, formation and types of Galaxies, Milky Way Galaxy, Types and properties of stars, Nebulae and Supernova, Solar system models, Sun, Planets, Moon, Comet and Asteroids, planetary orbits, Atmosphere of planets and Magnetosphere.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Nicola Vittorio, "*An Overview of General Relativity and Space-Time*" 1st edition, CRC Press, 2022.

Reference Book(s)

1. Bernard Schutz, "*A First Course in General Relativity*",3rd Edition, Cambridge University Press, 2022.

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PH-413 Surface Science			
	Cr. Hrs.	**Contact Hrs.**	**Exam Marks**
Th.	3	3	100
Pr	0	0	0

Basic of Surface Sciences: Surface reactions, adsorption phenomena, Heterogeneous catalysis, Semiconductor technology, Corrosion, Nanotechnology, Surface Structure and *Classification of solids, Crystal structure, Unit cell, Bravais lattices, the Band structure of metals, insulators and semiconductors, Fermi level,* Screening, Work Function, Surface States, Electron Affinity, Ionization Potential, Surface Chirality, Thermodynamics of Surfaces, Equilibrium Crystal Shape.

Quantum Confinement of Electrons at Surfaces: Nucleation and growth of nanostructures and films, Surface Magnetism and magnetic imaging, *Diamagnetism, Para magnetism, Anti-Ferromagnetism, Magnetism in thin films.*

Microscopic and Spectroscopic Techniques: Kerr microscopy (MOKE), Spin-Polarized Photoemission (SP-PEEM), Magnetic Force Microscopy (MFM), Surface Study Techniques and comparison of Low-Energy Electron Diffraction (LEED) and Reflection, High-Energy Electron Diffraction (RHEED), Near-Edge X-ray Absorption Fine Structure (NEXAFS), High-Resolution Electron Energy Loss Spectroscopy (HREELS), Desorption Techniques, Electron Spectroscopy, mean free path, Koopman's Theorem, Spin-orbit coupling effects, chemical shifts, binding energy, Electron Analyzer, Electron optics, Scanning Tunneling Microscopy (STM).

Applications: Silicon Surfaces, Molecular Adsorption on Semiconductor Surfaces, Adsorption Properties of CO on Metal Single-Crystal Surfaces, Molecular or dissociative adsorption, Chemical bonding, and Orientation, Adsorption Site as a function of coverage, Overlayer long-range order, Ammonia Synthesis, Oxide Surfaces, Photovoltaic, and Organic Electronics.

Recommended book(s) for the approved course
(Author's name, "*Title",* edition, publisher, publication year).

Text book(s)

1. Mario Rocca, Talat Rahman ,Luca Vattuone, "*Springer Handbook of Surface Science*", Springer, ·2021.
2. Kurt W. Kolasinski, "*Surface Science: Foundations of Catalysis and Nanoscience*", 4th edition, Wiley, 2019.

Reference Book(s)

1. Yury Gogotsi, V. Domnich, "*High Pressure Surface Science and Engineering*", 1st edition, CRC Press, 2019

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REGISTRAR

To,

Chairperson, Department of Physics

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2- Controller of Examinations
3- Director, I.T. Department
4- Deputy Registrar (Cdn)
5- Mr. Muhammad Riaz
Ag. Assistant Registrar (Academic)

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2- PA to Pro-Vice Chancellor
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