### B. Sc.(Hons.) Physics
#### Three-Year Programme
#### Academic Curriculum (2015 – 16 onwards)

**Third Year**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Contact Hours per Week</th>
<th>Credits</th>
<th>ETE Duration Hours</th>
<th>Weightage (%)</th>
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<tr>
<td>PH 311</td>
<td>Quantum Mechanics and Spectroscopy</td>
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<td>Electromagnetic Theory</td>
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<td>PH 341</td>
<td>Atomic and Molecular Physics</td>
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<td>PH 351</td>
<td>Elements of Classical Mechanics</td>
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<td>PH 361</td>
<td>General and Optics Based Laboratory</td>
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Proficiency (Non-Credit) #

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<tr>
<th>Course Code</th>
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<td>PH 342</td>
<td>Solid State Physics</td>
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<td>Nuclear and Particle Physics</td>
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<td>Statistical Mechanics</td>
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<td>PH 372</td>
<td>Basics of Nanoscience and Exotic Materials</td>
<td>3 - - 3 3</td>
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<td>Solid State and Nuclear Laboratory</td>
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<td><strong>Sub Total</strong></td>
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Proficiency (Non-Credit) #

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**CW:** Course Work; **MTE:** Mid Term Examination; **ETE:** End Term Examination  
*Course work (CW) would include regularity, evaluation of assignments, surprise tests, etc.*  
*Evaluation of proficiency will be based on the participation in extra-curricular/co-curricular activities.*

**Note:**
1. The Programme includes two types of subsidiaries:
   - (i) Chemistry and Maths
   - (ii) Maths and Computer Science

2. In addition to the compulsory courses, either all courses of Chemistry Or Computer Science may only be opted in each semester of first two years.

**Credits:** Physics: 64, Maths: 26, Chemistry: 26, Comp Sc.: 26

**Total Credits (With Chemistry and Maths as Subsidiaries)** 129
**Total Credits (With Computer Science and Maths as Subsidiaries)** 129
PH 311  Quantum Mechanics and Spectroscopy  3-1-0-4

**Failure of Classical Physics:** Black body radiation (without derivation), Photoelectric effect, Compton effect Wave Packets and Uncertainty Relation: de-Broglie hypothesis, Wave-particle duality, Wave packets, Group velocity and phase velocity, Uncertainty principle.

**Wave Mechanics:** Schrödinger equation, Physical interpretation of wave function, Probability current density and conservation of probability, Free particle wave function, Schroedinger equation in the presence of a potential, Linear operators, Hermitian operators, Observables, Eigenvalues and Eigenfunctions, Expectation values, Ehrenfest's theorem, Commutation relations

**Schrödinger Wave Equation and Applications:** Particle in one dimensional Box, Square well, Rectangular potential barrier and tunneling, Linear harmonic oscillator, Spherically symmetric potential, Angular momentum operators and their eigen functions, Concept of spin, Hydrogen atom.


**Text Books:**
1. V. Devanathan: Quantum Mechanics
2. S.L. Kakani, C. Hemrajani, T.C. Bansal, Elementary Quantum Mechanics and Spectroscopy, CBC, Jaipur

**Reference Books:**
1. Loknathan and Ghatak: Quantum Mechanics
2. S. Gasiorowicz: Quantum Physics
3. B. H. Bransden and C. J. Joachain: Quantum Mechanics:
4. H.E. White, Introduction to Atomic Physics
1. **Maxwell’s Equations**: Concept of Displacement Current, Vector and Scalar Potentials, Boundary Conditions at boundary of different media, Wave equations and plane waves in Dielectric media, Poynting Theorem, Physical concept of Electromagnetic field, Energy density, Momentum density.

2. **Reflection and Refraction of EM Waves**: Reflection and refraction of a plane wave by interface between dielectrics, Fresnel Formulae, Total internal reflection, Brewster’s angle, Waves in conducting media, Metallic reflection for normal incidence.

3. **Plasma and Ionosphere**: Concept of skin depth, Microscopic media (Plasma) and Maxwell’s equations, Plasma frequency, Refractive index, Conductivity of an ionized Gas, Propagation of e.m. waves through Ionosphere.

4. **Polarization of EM Waves**: Different types of polarizations (Linear, Circular and Elliptical), e.m. Fresnel’s formula, Uniaxial and biaxial crystals, Polarization by double refraction, Nicol Prism, Ordinary and Extraordinary Refractive indices, Phase retardation plates: Quarter-Wave and Half-Wave Plates, Analysis of Polarized Light, Polarimeter.

5. **Rotatory Polarization**: Optical rotation, Biot’s Laws for Rotatory Polarization, Fresnel’s Theory of Optical Rotation, Experimental verification of Fresnel’s Theory, Specific Rotation, Laurent’s Half-Shade Polarimeter.

6. **Fiber Optics**: Planar Optical Wave Guides, Propagation through optical fiber, Types, Numerical aperture, Modes of Propagation (Basic Concepts only).

**Text Books:**

**Reference Books:**
PH 341  Atomic and Molecular Physics  4-0-0-4

1. **Atomic Physics:** Spectra of Hydrogen, Deuteron and alkali atoms spectral terms, doublet fine structure, screening constants for alkali spectra for s, p, d and f states, selection rules. [7]

2. **Earth Spectra:** Singlet and triplet fine structure in alkaline earth spectra [5]

3. **Week spectra:** continuous X-ray spectrum and its dependence on voltage, Duane and Hunt’s law. Characteristic X rays, Moseley’s law, doublet structure of X-ray spectra, X-ray absorption spectra. [8]

4. **Molecular Physics:** Discrete set of electronic energies of molecules, quantization of vibrational and rotational energies, determination of internuclear distance, pure rotational and vibrational spectra. [10]

5. **Vibration Spectra:** Dissociation limit for the ground and other electronic states, transition rules for pure vibration and electronic vibration spectra. [6]

6. **Raman Effect:** raman Effect, Stokes and anti-Stokes lines, complimentary character of Raman and infrared spectra, experimental arrangements for Raman spectroscopy. [8]

7. **Spectroscopic Techniques:** Sources of excitation, prism and grating spectrographs for visible, UV and IR, absorption spectroscopy, double beam instruments. [8]

**Text Books:**

**Reference Books:**
2. D. P Khandelwal : Optics and Atomic Physics, Shiva Lai Agarwala & Company, Educational Publisher, 1973
PH 351  Elements of Classical Mechanics  2-0-0-2

1. System of particles, Constraints, Generalized coordinates, D'Alemberts principle and Lagrange's equation, Velocity dependent potential of electro-magnetic field. [10]


Text Books

Reference Books:

PH 361  General and Optics Based Laboratory  0-0-4-2

Assignments are based on the course PH 341, etc

PH 371  Electronics Laboratory  0-0-4-2

Assignments are based on the course PH 331, etc
1. **Structure**: Crystal structure, periodicity, lattices and bases, fundamental translational vectors, unit cell, lattice types, Bravais lattices, Miller indices for direction and planes, Common crystal structures like NaCl, ZnS and Diamond; Close packed structures, Lau theory of X-ray diffraction, X-ray diffraction, Bragg’s law.

2. **Bonding**: Potential between a pair of atoms, concept of cohesive energy, covalent, Vander Waals, ionic and metallic Crystals, reciprocal lattice, Brillouin Zones


4. **Electronic Properties**: Free electron gas, Electrons in periodic potential, Kronig-Penny model, Bloch theorem, energy bands, metals, insulators and semiconductors; Hall Effect, Fermi surface

5. **Magnetic Properties**: Magnetic moment, magnetic susceptibility, Dia-, Para and Ferromagnetism, Ferromagnetic domains.

Text Books:

Reference Books:
1. **Nuclear Structure**: Properties of Nuclei and Models, Introduction to the nucleus, Fermi gas model, Deuteron Binding energy, Semiemperical mass formula, Mass diffect, Packing fraction and its application to explain most stable isobars and nuclear fission, Magnetic dipole moment, quadrapole moment, angular momentum, Effect of mass number on size of nucleus Condition of stability for isobars.

2. **Nuclear Models**: Liquid drop model, fission and potential barrier, N-N and P-P chains, Nuclear reactors, Nuclear fission and fusion.


4. **Nuclear Stability**: Nucleon emission, separation energy, Alpha decay and its energy spectrum, WKB Approximation, Beta decay and its energy spectrum ( for example,137Cs), Need for neutrinos, Q-values, Gamma decay, Parity and Selection rules for gamma transitions (no derivation).


6. **Elementary Particles**: Properties of particles, classification in to leptons mesons and baryons, matter and antimatter, conservation laws (qualitative discussion), energy, momentum, angular momentum, charge, lepton number, Baryon number, Isospin, strangeness.

7. **Classification of Particles**: Interactions, Quantum numbers, Quarks as the building blocks of hadrons, Colour degree of freedom.

**Text Books**:
3. S.L.Kakani, C. Hemrajani, T.C. Bansal, Nuclear Physics, CBC, Jaipur, 2005
4. S. N. Ghosal: Nuclear Physics, S. Chand Limited, 1997

**Reference Books**:
2. H.A. Enge, Introduction to Nuclear physics, Addison Wesley, Publishing company, Inc. New York, 1 974
PH 362 Statistical Mechanics

1. **Random Walk Problem:** Probability distribution, Mean and Dispersion and Simple Numerical Problems. [8]

2. **Basic Concepts of Statistical Physics:** Entropy and thermodynamic probability, Ensemble theory, partition function, applications to classical ideal gas, Gibbs paradox; Statistical equivalence of three ensembles. [7]


5. **Bose-Einstein’s Condensation:** B-E Distribution law, Completely Degenerate Bose Gas, Bose-Einstein condensation, Properties of liquid He, Radiation as photon gas. [10]


**Text Books:**
1. Frederick Reif: Fundamentals of Statistical and Thermal Physics, Waveland Press 2009

**Reference Books:**
PH 372  Basics of Nano-Science and Exotic Materials  3-0-0-3


2. **Basic Concepts of Nanomaterials**: Physical, Chemical and Bio-routes for Synthesis of Nanomaterials (basic idea), Metal Nanoparticles, Carbon Nanostructures, Electronic Properties of Nanomaterials, Nano photonics, Some applications of Nano Materials. [15]


4. **Quasicrystals**: Basic definition of quasicrystal and Structure of Quasicrystals. [4]

**Text Books:**

**Reference Books:**

PH 382  Solid State and Nuclear Laboratory  0-0-4-2

Assignments are based on the course PH 342, PH 352, etc

PH 392  Optoelectronics Laboratory  0-0-4-2

Combined Assignments are based on Lasers, Optical Fibers, PH 341, etc.