POST GRADUATE DEPARTMENT OF PHYSICS

UNIVERSITY OF KASHMIR, SRINAGAR

Choice Based Credit System

Course Curriculum (Syllabus for Examination)

For the Academic Years
2015, 2016 &
2017

Summary of all the courses

Semester – I				
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**	**Teacher**
Core (CR)	PHY15101CR	Mathematical Physics – I	04	
	PHY15102CR	Quantum Mechanics – I	04	
	PHY15103CR	Lab. Course	04	
Discipline Centric Electives (DCE)	PHY15104DCE	Classical Mechanics	04	
	PHY15105DCE	Antenna and Wave Propagation	04	
	PHY15106DCE	Electronics – I	02	
Generic Electives (GE)	PHY15107GE	Physics Education	02	
	PHY15108GE	Introduction to Astronomy	02	
	PHY15109GE	Philosophical foundations of Quantum Mechanics	02	
Open Electives (OE)	PHY15110OE	Biophysics	02	

Semester – II				
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**	**Teacher**
Core (CR)	PHY15201CR	Statistical Mechanics	04	
	PHY15202CR	Electrodynamics – I	04	
	PHY15203CR	Lab. Course	04	
Discipline Centric Electives (DCE)	PHY15204DCE	Mathematical Physics – II	04	
	PHY15205DCE	Quantum Mechanics – II	04	
	PHY15206DCE	Advanced Digital Systems	02	
Generic Electives (GE)	PHY15207GE	Tensor Analysis	02	
	PHY15208GE	Crystallography	02	
	PHY15209GE	Electronics – II	03	
Open Electives (OE)	PHY15210OE	Renewable Energy Resources	02	
	PHY15211OE	Philosophical Foundations of Physics	02	

Semester – III

Course Type	Course Code	Title of the Course	No. of Credits	Teacher
Core (CR)	PHY15301CR	Nuclear Physics	04	
	PHY15302CR	Condensed Matter Physics	04	
	PHY15303CR	Atomic and Molecular Physics	04	
Discipline Centric Electives (DCE)	PHY15304DCE	Astrophysics – I	03	
	PHY15305DCE	Electrodynamics – II	03	
	PHY15306DCE	Field Theory – I	03	
	PHY15307DCE	Seminar/Oral presentation/Demonstration	02	
Generic Electives (GE)	PHY15308GE	Microwave Devices and Circuits	02	
	PHY15309GE	Advanced Lab. Methods	02	
	PHY15310GE	Superconductivity	02	
Open Electives (OE)	PHY15311OE	Lasers	02	
	PHY15312OE	Radioactivity and Environmental Radon	02	

Semester – IV				
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**	**Teacher**
Core (CR)	PHY15401CR	Particle Physics	04	
	PHY15402CR	Physics of Nano-materials	04	
	PHY15403CR	Computational Methods in Physics	04	
Discipline Centric Electives (DCE)	PHY15404DCE	High Energy Physics	02	
	PHY15405DCE	Astrophysics – II	03	
	PHY15406DCE	Field Theory – II	03	
	PHY15407DCE	Project	04	
	PHY15408DCE	Neutrino Physics	02	
Generic Electives (GE)	PHY15409GE	Density Functional Theory	04	
	PHY45410GE	Atmospheric Physics	04	
	PHY15411GE	Bose-Einstein Condensate	02	
Open Electives (OE)	PHY15412OE	Modern Communication Systems	02	
	PHY15413OE	Astronomical Techniques	02	

SEMESTER – II

Semester – II				
Course Type	**Course Code**	**Title of the Course**	**No. of Credits**	**Teacher**
Core (CR)	PHY15201CR	Statistical Mechanics	04	
	PHY15202CR	Electrodynamics – I	04	
	PHY15203CR	Lab. Course	04	
Discipline Centric Electives (DCE)	PHY15204DCE	Mathematical Physics – II	04	
	PHY15205DCE	Quantum Mechanics – II	04	
	PHY15206DCE	Advanced Digital Systems	02	
Generic Electives (GE)	PHY15207GE	Tensor Analysis	02	
	PHY15208GE	Crystallography	02	
	PHY15209GE	Electronics – II	03	
Open Electives (OE)	PHY15210OE	Renewable Energy Resources	02	
	PHY15211OE	Philosophical Foundations of Physics	02	

Semester II

Statistical Mechanics

Course No: **PHY15201CR**	Max. Marks:	100
	External Examination:	80
No. of credits: **04**	Internal Assessment:	20

UNIT – I

Statistical Distributions; Statistical independence, Liouvilles theorem, Significance of energy, Statistical Matrix, Statistical Distributions in quantum Statistics, Microcanonical, Canonical and Grand Canonical ensemble, Partition Function, Calculation of Statistical Quantities, Energy and Density Fluctuations.

UNIT – II

Gibbs distribution, Maxwellian distribution, Probability distribution for an Oscillator, Free energy in the Gibbs distribution, Expansion in powers of $\hbar$, Gibbs distribution for rotating bodies and for a variable number of particles, Derivation of thermodynamics relations from the Gibbs distribution

UNIT – III

Fermi distribution, Bose distribution, Fermi and Bose gases of elementary particles, Degenerate electron gas, Specific heat of degenerate electron gas, Weak fields, Strong fields, Relativistic degenerate electron gas, Degenerate Bose gas, Black body Radiation.

Deviation of gases from the ideal state, Expansion in powers of density, Relationship of the virial coefficients.

UNIT – IV

Conditions for phase equilibrium; the Clapeyron-Clausius formula, Critical point, Law of Corresponding states, Phase transitions of the second kind, Discontinuity of Specific heat, Effect of an external field on a phase transition, Change in symmetry in a phase transition of the second kind, Fluctuations of the order parameter, Critical indices, scale invariance, Isolated and Critical points of Continuous transition, Phase transition of the

second kind in a two dimensional lattice.

Text Book:

1. Statistical Physics, Landau and Lifshitz, Butterworth-Heinemann, An Imprint of Elsevier, Linacre House, Jordan Hill, Oxford OX2 8DP, UK

Reference Books:

1. Statistical Mechanics, by K Huang
2. Statistical and Thermal Physics, by F. Reif
3. Statistical Mechanics by Pateria
4. Fundamentals of Statistical Mechanics by B.B. Laud
5. Statistical Mechanics by R.K.Srivastava & J. Ashok
6. Thermodynamics and Statistical Mechanics by Greiner, Neise and Stocker

Semester II

Electrodynamics – I

Course No: **PHY15202CR**	Max. Marks:	100
	External Examination:	80
No. of credits: **04**	Internal Assessment:	20

UNIT – I

Review of: Coulomb's Law, Electrostatic field, Gauss's law and Differential form of Gauss's law, Scalar potential, Surface distributions of charges and dipoles, Poisson's and Laplace's equation, Green's theorem, Uniqueness theorem, Formal solution of boundary-value problem, Green's functions, Electrostatic potential energy

Method of images, Point charge and grounded conducting sphere, Point charge and conducting sphere in uniform field, Method of inversion, Green's function for sphere, Conducting sphere with hemi-spheres at different potentials, Orthogonal functions and expansions, Separation of variables in rectangular co-ordinates

UNIT – II

Boundary value problems in cylindrical co-ordinates, Expansion of Green's function in spherical co-ordinates, Eigen function expansion of Green's functions, Mixed boundary conditions, charged conducting disc

Multiple expansion, Multiple expansion of the energy of a charge distribution in external field, Macroscopic electrostatics, Simple dielectrics and boundary conditions, Molecular polarizability and electric susceptibility, Modes of Molecular polarizability, Electrostatic energy in dielectric media

UNIT – III

Review of: Biot and Savart law, Differential equations of magnetostatics and Amperes law, Vector potential, Magnetic induction of a circular loop of current, Localized current distribution, Magnetic moment, Force and torque on localized currents in the external field, Macroscopic equation, Boundary conditions, Uniformly Magnetized sphere, Magnetized sphere in an external field, Permanent magnets

Faraday's law of Induction, Energy in Magnetic field, Maxwell's Displacement

current, Maxwell's equations, Vector and scalar potentials, wave equations, Guage transformation, Green's function for time-dependent wave equation, Initial value problem, Kirchhoff's integral representation, pointing theorem, conservation laws, Macroscopic equations

UNIT – IV

Plane waves in non-conducting media, linear and circular polarization, Superposition of waves, group velocity, propagation of pulse in dispersive medium, reflection and refraction, polarization by reflection, total internal reflection, Waves in conduction media. Simple model for conductivity, transverse waves in tenuous plasma

Field at the surface of and within the conductor, cylindrical cavities and wave guides, Wave Guides, modes in a rectangular wave guide, Energy flow and attenuation in a wave guides, resonant cavities, power losses in cavity, Dielectric wave guides

Text Book:

1. Classical Electrodynamics, by John David Jackson, John Wiley & Sons Inc

Reference Books:

1. he Classical Theory of Fields, L. D. Landau and E. M. Lifshitz, Butterworth Heinman
2. Introduction to Electrodynamics, David J. Griffiths, Pearson Education

Semester II

Lab. Course

Course No: **PHY15203CR**	Max. Marks:	100
	External Examination:	50
No. of credits: **04**	Internal Assessment:	50

Description

There shall be about 20 experiments available in the lab out of which the student shall have to complete at least 06 experiments in this semester.
The list of experiments presently available is as follows:

- To determine the wave length of a laser with a diffraction grating.
- To determine the energy gap of a semiconductor using Four probe method.
- To determine the curie temperature of an electrical material BaTio3
- To determine the dead time and absorption Co-efficient using G.M.Counter.
- ESR: Electron Spin Resonance.
- To determine the velocity of ultrasound in a given liquid medium (kerosene)
- To determine the Hall coefficient for a semiconductor sample.
- Designing and studying RC filters Active and Passive.
- To Determination of e/m ratio of electron by J.J.Thomson's method.
- To Determination of e/m ratio of electron by Helical method
- To determine the velocity of sound using lissajous figures.
- Determination of Plank's constant using Photoelectric Effect.
- Antenna measurements
- Fabry-Perot Interferometer
- Study sinusoidal steady-state response of a resonant circuit in the phasor domain.
- To determine the characteristics of a Solar Cell.
- Study Digital Fiber Optical Transmitter and Receiver.
- Fast Fourier Transform (FFT) in Excel

Note: The experiments to be performed in this semester shall be different from those completed in the 1st Semester.

Semester II

Mathematical Physics - II

Course No: **PHY15204DCE**	Max. Marks:	100
	External Examination:	80
No. of credits: **04**	Internal Assessment:	20

UNIT – I

Green's Functions in One Dimension: Calculation of Green's Functions for simple differential operators, Green's Functions for Second order Linear Differential Operators (SOLDOs), Self Adjoint SOLDOs, Generalized Green's identity.

Multidimensional Green's Functions: Second-Order PDEs in m Dimensions, Multidimensional GFs and Delta Functions, Spherical Coordinates in m Dimensions, Green's Function for the Laplacian.

UNIT – II

Probability: Definition and simple properties, Discret and Continous Random variables, Binomial distribution, Poisson and Gaussian distributions, Central limit theorem.

Statistics: Error propagation, Fitting curves to data, The Chi-square distribution. Students t distribution.

UNIT – III

Fourier Series, Properties and Applications. Fourier transform, Sine, Cosine and Complex transforms with examples, Definition, Properties and Representations of Dirac Delta Function, Properties of Fourier Transforms, Transforms of derivatives, Applications to Partial differential equations. Laplace transform, Properties and examples of Laplace Transform, Laplace transform method of solving differential equations.

UNIT – IV

Numerical analysis: interpolation, Finite difference, Forward, Backward and Central differences, Symbolic relations and separation of symbols, detection of errors by using difference tables, Newon's formula, Gauss central difference interpolation, Lagrange interpolation formulation, Integration by tapezoid and Simpson's rule, solve first order differential equations using Taylor, Eular and Runge-Kutta methods .

Text Books:

1. Mathematical Methods for Physicists (6th Ed.), G. B. Arfken and H. J. Weber, Academic Press
2. Mathematical Physics: A Modern Introduction to Its Foundations, Sadri Hassani, Springer (2002)

3. Intorductory methods of numerical analysis (5^{th} Ed.) S. S. Shastri, PHI Learning Pvt. Ltd. (2010)

Reference Books:

1. Numerical Mathematical Analysis (6^{th} Ed.) J. B. Scarborough, Oxford
2. Elements of Group Theory for Physicists (2^{nd} Ed.) A. W> Joshi, Wiley
3. Group theory and its applications to physical problems, Morton Hammermesh, Addison-Wiley Publishing Co. (1962)
4. Probability in Physics by Y. Ben-Menaheml and M. Hemmo, Spring-Verlag, berlin-Heidelberg (2012).
5. Mathematical Methods For Students of Physics and Related Fields, Sadri Hassani, Springer (2009)
6. Advanced Engineering Mathematics by Michel D, Greenberg
7. Mathematical Methods for Physics and Engineering (3rd Ed.), Riley, Hobson and Bence, Cambridge
8. Advanced Engineering Mathematics, E Kreyzig (8th Ed.), Wiley

Semester II

Quantum Mechanics – II

Course No: **PHY15205DCE**	Max. Marks:	100
	External Examination:	80
No. of credits: **04**	Internal Assessment:	20

UNIT – I

Time-independent perturbation theory, Non-degenerate & degenerate cases, Applications such as linear harmonic oscillator, Zeeman effect, Stark effect, Perturbation of the type X^2, X^3, X^4.

Variational method and its applications, WKB approximation, Solution of bound state problems, Time -dependent perturbation theory, Harmonic perturbation, Fermi's golden rule, Adiabatic and sudden approximation.

UNIT – II

Collision in 3-D and scattering, Laboratory and CM reference frames, Scattering amplitude, differential scattering cross and total scattering cross, Scattering by spherically symmetric potentials, Partial waves and phase shifts, Scattering by a perfectly rigid sphere and by square well potential, Complex potential and absorption.

UNIT – III

Identical particles, Symmetric and antisymmetric wave functions, Spin and Statistics, The Exclusion Principle, Distinguishability of Identical Particles, Collision of identical particles; Spin angular momentum, Spin functions for a many-electron system.

Semi classical theory of radiation, Transition probability for absorption and induced emission, Electric dipole and forbidden transitions.

UNIT – IV

Relativistic QM: The Klein-Gordon equation, Free particle solutions, probability density & probability current density, interpretation of negative energy solutions of the K-G equation. The Dirac equation, Free particle solutions, Probability density and probability density current for the free particle Dirac equation, Spin of an electron, Interpretation of negative energy

states.

Text Book:

1. L. l. Schiff, Quantum Mechanics (McGraw-Hill), New York Toronto London, Kogakusha Company, Ltd. Tokyo

Reference Books:

1. Cohen, Diu and Laloe Quantum Mechanics
2. A. P. Messiah, Quantum Mechanics
3. J. J. Sakurai, Modern Quantum Mechanics
4. Mathews and Venkatesan, Quantum Mechanics
5. Bjorken & Drell, Relativistic Quantum Mechanics
6. J. R. Aitchson, Relativistic Quantum Mechanics
7. W. Greiner, Relativistic Quantum Mechanics

Semester II

Advanced Digital Systems

Course No: **PHY15206DCE**	Max. Marks:	50
	External Examination:	40
No. of credits: **02**	Internal Assessment:	10

UNIT – I

Review of Basic Digital Concepts and logical gates,Brief introduction of VLSI Design and Implementation, Traditional vs. Hardware Description Languages, Digital System Design Flow, The Role of Hardware Description, VHDL, Levels of Abstraction, Scope of VHDL, Benefits of using VHDL, VHDL Examples.

UNIT – II

Intro to FPGA, Xilinx ISE , FPGA Prototyping by VHDL Examples: ISE/Spartan 3 FPGA Implementation Walkthrough , Xilinx Spartan-3, Design Examples with Xilinx ISE and Spartan 3**E,** Programming the FPGA, Project.

References :

Digital Integrated Circuits second edition by John M Rabaey, Anantha Chandrakasan

Text

VHDL Starters Guide Sudhakar Yalamanchili Publisher: Prentice Hall , ISBN: 0-13-145735-7

Forms of examination

The student's knowledge will be tested by a written exam in combination with written and/or oral presentations of the Projects.

Aims: To familiarize students with the basic principles of digital systems design and the use of a hardware description language, VHDL, and xilinx software in the

design process..

Semester II

Tensor Analysis

Course No: **PHY15207GE**	Max. Marks:	50
	External Examination:	40
No. of credits: **02**	Internal Assessment:	10

UNIT – I

Transformation of coordinates, properties of admissible transformation of coordinates, transformation by invariance, transformation by covariance and contravariance. Tensor concept, contranvariant and covariant tensors. Algebra of tensors, quotient laws, symmetric and anti-symmetric tensors, relative tensors, metric tensor . Fundamental and associated tensors. Christoffel symbols and transformation.

UNIT – II

Covariant differentiation of tensors, formulas for covaraiant differentiation of tensors. Tensor form of differential operators. Ricci Theorem, Riemann-Christoffel tensor and its properties. Ricci Tensor, Bianchi identities, Einstein tensor. Existence theorem. Some applications to analytical mechanics.

Text Book:

1. I. S. Sokolnikoff: Tensor Analysis.

Semester II

Crystallography

Course No: **PHY15208GE**	Max. Marks:	50
	External Examination:	40
No. of credits: **02**	Internal Assessment:	10

UNIT – I

Crystalline solids and their growth methods. Crystal lattice; two and three dimensional lattices, crystal planes and directions. Crystal symmetry, crystallographic point groups and their applications. Space groups, graphical representation of space groups, building crystal structure from space groups, crystal structure of some simple compounds. Direct and reciprocal lattice. Reciprocal lattice of simple, body centered and face centered cubic lattices.

UNIT – II

Diffraction of Waves by Crystals, Scattered Wave Amplitude, Fourier Analysis of a crystal structure. Reciprocal Lattice and its applications to diffraction techniques, Diffraction Conditions, Brillouin Zones, Crystal structure factor and intensity of diffraction maxima, atomic scattering factor. Extinctions due to lattice centering. Powder X-ray diffraction, Single crystal X-ray diffraction. Structure determination using X-ray diffraction.

Text Books :

1. Crystal and crystal structure by Richard Tilley , Willey Pub.
2. Introduction to Solid State Physics by Charles Kittel, Willey Publication.

Reference Books :

1. An Introduction to Crystallography by M.M. Woolfson, Cambridge University Press.
2. Structure and Bonding in Crystalline Materials by G.S. Rohrer, Cambridge University Press.

Semester II

Electronics – II

Course No: **PHY15209GE** Max. Marks: 75

External Examination: 60

No. of credits: **03** Internal Assessment: 15

UNIT – I

Logic gates,Sequential and Combinational circuits, Commonly used gates, Boolean Algebra , DeMorgan's Theorem and Examples, DeMorgan's in Gates.Logic Minimisation, Truth Tables, , Karnaugh Maps, K-maps examples, POS Simplification, POS Example, Number Representation,combinational logic ciruits and their implementation.

UNIT – II

Basic overiew of logic functions, Halfadder, Full adder, Half Subtracter, Full Subtracter, Multiplexers, Demultiplexers, Encoder , Decoders Latches,Edge triggered flip flops, Master slave flip flops, Flip flop operating characteristics and applications Asynchronous, Synchronous operations up/down counters .CMOS and TTL circuits and their comparison.ECL circuits

UNIT – III

Multivibrators and clock circuits, up and down shift registers, ALU design, Finite state machines, Control unit designs, Digital system design concepts, approaches, PLD, Memories, A/D and D/A converters.

Texts Books

1. Tokhiem digital systems and principles and applications
2. R.J. Tocci., N.S.Widmer, G.L. Moss. Digital Systems, Principles and Applications, Pearson/Prentice Hall.
3. T.L.Floyd and Jain Digital Fundamentals, 8th Ed. Prentice Hall.
4. N.P. Cook. Practical Digital Electronics, Pearson/Prentice Hall.
5. W. Kleitz. Digital Electronics. A Practical Approach. Prentice Hall.

6. Wakerly: Digital System Design and Principles
7. M. M. Mano: Digital Design
8. C. E. Strangio: Digital Electronics: Fundamental Concepts and Applications.
9. W. Kleitz. Digital Electronics with VHDL, Pearson/Prentice Hall.
10.

Semester II		
Renewable Energy Resources		
Course No: **PHY15210OE**	Max. Marks:	50
	External Examination:	40
No. of credits: **02**	Internal Assessment:	10

UNIT – I

Energy Senerio:

Global Energy Scenario, Energy & GDP, energy consumption and Projected future demands,

Non Renewable Energy Resources: Coal, Oil, Natural Gas, Nuclear Power.

Renewable Energy Resources : Hydroelectricity. Solar Energy:

Sun as Source of Energy, Nature of Solar Radiation, Photo thermal Systems, Photovoltaic systems. Geothermel Energy

UNIT – II

Wind Energy:

Wind Energy Fundamentals, Wind Measurements, Analysis and Energy Estimates , Aerodynamics Theory, Wind Turbines Technology, Issues and challenges in the wind energy sector.

Biomass Energy:

Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biomass gasifiers Concept of Bio-energy: Photosynthesis process, Bio-fuels, Biomass resources Bio based chemicals and materials , Thermo-chemical Conversion: Pyrolysis, Combustion, Bio-fuels: Importance, Production and applications.

Hydrogen:

Hydrogen and energy source, Potential advantages, Hydrogen economy and its components, Hydrogen fuel cell. Global renewable energy trends.

Text Books:

1. Energy Economics: Concepts, Issues, Markets and Governance Subhes C. Bhattachary

2. Methane Production Guide - how to make biogas. Three simple anaerobic digesters for home construction by Richard Jemmett
3. Free Renewable Energy Book by The Clearlight Foundation
4. Energy systems and sustainability by Godfrey Boyle

References Books:

1. Energy Systems and Sustainability by Godfrey Boyle
2. Energy Systems and Sustainability: Power …Bob Everett
3. Sustainable Energy - David J.C. MacKay
4. Energy Science: Principles, John Andrews
5. Environmental Law Stuart Bell

Forms of examination

The student's knowledge will be tested by a written examination.

Aims and Objective: Course details

The course aims to develop an understanding of the existing and emerging renewable energy technologies. It covers basics of different sources and forms of renewable energy, status of these sources in India .

Semester II

Philosophical Foundations of Physics

Course No: **PHY15211OE**	Max. Marks:	50
	External Examination:	40
No. of credits: **02**	Internal Assessment:	10

UNIT – I

Galileo's perspective; background, basic issues, natural philosophy, Newtonian framework; a revolution, broad coherence, Newton's absolute space, physics through determinism, coordinates, manifolds and Metrics; the building blocks , Aristotelian & Newtonian space-time, Galilean space The Leibniz-Clarke debate, handedness' and space.

UNIT – II

Special Relativity: Albert Einstein and his skeptiscism about classical physics, the postulates, Minkowski space-time, time topology and twin paradox, the most famous equation $E=mc^2$. what does it really mean? General Relativity: curved spaces and curved space-time, a conventional world, relationism versus substantivalism, the geometry of time, time travel as a technical problem, the direction of time.

Textbooks:

1. Philosophical Concepts in Physics: The Historical Relation between Philosophy and Scientific Theories by James T. Cushing
2. From Paradox to Reality: Our Basic Concepts of the Physical World by Fritz Rohrlich