POST GRADUATE DEPARTMENT OF PHYSICS

UNIVERSITY OF KASHMIR, SRINAGAR - 190 006

Course Curriculum (Syllabus for Examination)

For the academic years

2021, 2022 and 2023

Summary of all the courses

Semester - I			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18101CR	Mathematical Physics - I	04
	PHY18102CR	Quantum Mechanics - I	04
	PHY18103CR	Lab. Course	04
Discipline Centric Electives (DCE)	PHY18104DCE	Classical Mechanics	04
	PHY18105DCE	Antenna and Wave Propagation	04
	PHY18106DCE	Electronics	04
Generic Electives (GE)	PHY18107GE	Introduction to Astronomy	02
	PHY18108GE	Environmental Physics	02
Open Electives (OE)	PHY18109OE	Biophysics	02

Semester - II			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18201CR	Statistical Mechanics	04
	PHY18202CR	Electrodynamics	04
	PHY18203CR	Quantum Mechanics - II	04
	PHY18204CR	Lab. Course	04
Discipline Centric Electives (DCE)	PHY18205DCE	Mathematical Physics - II	04
	PHY18206DCE	Digital Electronics	04
	PHY18207DCE	Fluid Dynamics	04
Generic Electives (GE)	PHY18208GE	Renewable Energy Resources	02
	PHY18209GE	Crystallography	02
Open Electives (OE)	PHY18210OE	Philosophical Foundations of Physics	02

Semester - III				
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**	
Core (CR)	PHY18301CR	Nuclear Physics	04	
	PHY18302CR	Condensed Matter Physics	04	
	PHY18303CR	Atomic and Molecular Physics	04	
	PHY18304CR	Physics of Nano-materials	04	
Discipline Centric Electives (DCE)	PHY18305DCE	Astrophysics - I	02	
	PHY18306DCE	Atmospheric Physics - I	02	
	PHY18307DCE	Quantum Field Theory - I	02	
	PHY18308DCE	Superconductivity	02	
	PHY18309DCE	Laser Physics	02	
Generic Electives (GE)	PHY18310GE	Microwave Devices and Circuits	02	
	PHY18311GE	Experimental Methods	02	
Open Electives (OE)	PHY18312OE	Radiation Physics		

Semester - IV			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18401CR	Particle Physics	04
	PHY18402CR	Computational Methods in Physics	04
	PHY18403CR	Project	04
Discipline Centric Electives (DCE)	PHY18404DCE	High Energy Physics	02
	PHY18405DCE	Astrophysics - II	02
	PHY18406DCE	Atmospheric Physics - II	02
	PHY18407DCE	Quantum Field Theory - II	02
	PHY18408DCE	Neutrino Physics	02
	PHY18409DCE	General Relativity	02
Generic Electives (GE)	PHY18410GE	Modern Communication Systems	02
	PHY18411GE	Astronomical Techniques	02
Open Electives (OE)	PHY18412OE	Atmospheric Sciences	02

PHY18101CR **Mathematical Physics - I**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Complex functions, Analytic functions, Cauchy - Riemann conditions, Cauchy's Integral Theorem, Multiply connected regions, Singularities, Cauchy's Integral formula, Derivatives, Taylor and Laurent expansion, Analytic continuation, Poles and Branch Points, Calculus of Residues, Residue theorem, Cauchy principal value, Evaluation of Definite Integral using Cauchy's residues.

Unit - II

The Gamma Function: Definitions, Simple Properties, Factorial and Double factorial, Digamma and Polygamma Functions, Stirling's Series; The Beta Function, Legendre duplication formula. Infinite series, Convergence tests, Riemann Zeta Functions, Dirac Delta function and its properties

Unit - III

Partial Differential Equations, Classes and Characteristics, Boundary Conditions, First-order, Separable variables, Solution of linear first-order ODEs; Separation of variables in cartesian, Spherical Polar and Cylindrical Coordinates.

Singular points, Solution of Second order Differential Equations using Frobenius Method, Limitations of series approach; Second solution, Linear independence of solutions.

Orthogonal Functions, Self-Adjoint ODEs

Unit - IV

Bessel Functions of First kind, Orthogonality, Neuman Functions, Henkel Functions, Modified Bessel Functions, Spherical Bessel Function; Legendre Function, Orthogonality, Associated Legendre Function, Spherical Harmonics, Hermite Functions, Laguerre Functions.

Text Books:

1. Mathematical Methods for Physicists (7th Ed.), G. B. Arfken and H. J. Weber and F. E. Harris (Academic Press)

Reference Books:

1. Mathematical Methods For Students of Physics and Related Fields, Sadri Hassani, Springer (2009)
2. Mathematical Physics: A Modern Introduction to its Foundations, Sadri Hassani, Springer (2009)
3. Advanced Engineering Mathematics by Michel D, Greenberg
4. Mathematical Methods for Physics and Engineering (3rd Ed.), Riley, Hobson and Bence, Cambridge
5. Advanced Engineering Mathematics, E Kreyzig (8th Ed.), Wiley

PHY18102CR **Quantum Mechanics - I**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

The Double-Slit Experiment and Stern-Gerlach Experiment. Linear Vector Spaces, Inner Product Spaces and the Dirac Notation. Linear Operators, Matrix Elements of Linear Operators, Active and Passive Transformations, The Eigenvalue Problem, Functions of Operators and Related Concepts, Generalization to Infinite Dimensions. Uncertainity Relations.

Unit - II

Schrodinger's equation, Fundamental properties, Current density, General Properties of motion in one dimension, Potential well, Linear oscillator, Motion in a homogeneous field, Transmission coefficient and applications. Angular momentum, Eigenvalues and eigenfunctions of angular momentum. Symmetries and Their Consequences. Parity and time reversal invariance.

Unit - III

Addition of angular momentum, Clebsch-Gordon Coefficients, Symmetry Relations of CG coefficients, Evaluation of CG coefficients. Matrix representation of the rotation operators, CG series, Determination of the rotation matrices, orthogonality and normalization of the rotation matrices

Unit - IV

Motion in a centrally symmetric field, Spherical waves, Three dimensional oscillator, Resolution of a plane wave.Fall of a particle to the Centre, Motion in a coulomb field (spherical polar coordinates), Discrete and continuous spectrum, Coulomb problem in parabolic coordinate system.

Text Books:

1. R. Shankar, Principles of Quantum Mechanics

2. J. J. Sakurai, Modern Quantum Mechanics

Reference Books:

1. L. D. Landau and E. M. Lifshitz , Quantum Mechanics, Pergamon Press

2. K. Gotrified: Quantum Mechanics

PHY18103CR **Lab. Course**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **50** External Examination: **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.

List of Experiments

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
- Michelson Interferometer
- Fabry-Perot Interferometer
- Study of Regulated Power Supply
- 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

PHY18104DCE **Classical Mechanics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

The Lagrangian Approach to Mechanics: degrees of freedom, constraints and generalized coordinates, virtual displacement, virtual work and generalized force, d'Alembert's principle and the generalized equation of motion, the Lagrangian and the Euler Lagrange equation of motion, the Hamiltonian, cyclic coordinates and canonical momenta, applications; double pendulum, spherical pendulum, particle in electromagnetic field.

Unit - II

Variational calculus and Hamiltonian dynamics: the variational calculus and the Euler equation, the principle of least action and the Euler Lagrange equation, constraints in variational dynamics.

Hamiltonian dynamics: Legendre transformations, Hamilton's equations, conservation laws, phase space and Liouville's theorem.

Unit - III

Theoretical Mechanics: canonical transformations and generating functions, symplectic notation, Poisson Brackets (PB); the angular momentum PB relations, invariance of PBs under canonical transformations, action-angle variables and adiabatic invariance, the Hamilton Jacobi (HJ) Equation; HJ equation for Hamilton's characteristic function, separation of variables, particle motion under central force

Unit - IV

Oscillations: the simple harmonic oscillator; the damped harmonic oscillator, the damped simple and damped harmonic oscillator, coupled simple harmonic oscillators; couple pendulum, general method of solution.
Lagrangian and Hamiltonian of continuous systems: transition from discrete to continuous systems, the Hamiltonian formulation.

Text Books:

1. Classical Mechanics by Goldstein, Poole and Safko (Pearson Education)

2. Mechanics by Landau and Lifshitz

Reference Books:

1. Analytical Mechanics by L. N. Hand and J. D. Finch (Cambridge University Press)

PHY18105DCE **Antenna and Wave Propagation**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Antenna Fundamentals and Definitions: Radiation mechanism - over view, Electromagnetic Fundamentals, Solution of Maxwell's Equations for Radiation Problems, Ideal Dipole, Radiation Patterns, Directivity and Gain, Antenna Impedance, Radiation Efficiency. Antenna Polarization Resonant Antennas: Wires and Patches, Dipole antennas, Yagi - Uda Antennas, Micro strip Antenna

Unit - II

Arrays: Array factor for linear arrays, uniformly excited, equally spaced Linear arrays, pattern multiplication, directivity of linear arrays, non- uniformly excited -equally spaced linear arrays, Mutual coupling, multidimensional arrays, phased arrays, feeding techniques, perspective on arrays. Broad band Antennas: Traveling- wave antennas, Helical antennas, Biconical antennas; Principles of frequency - independent Antennas, spiral antennas, and Log - Periodic Antennas

Unit - III

Aperture Antennas: Techniques for evaluating Gain, reflector antennas - Parabolic reflector antenna principles, Axi -symmetric parabolic reflector antenna, offset parabolic reflectors, dual reflector antennas, Gain calculations for reflector antennas, feed antennas for reflectors, field representations, matching the feed to the reflector, general feed model, feed antennas used in practice

Unit - IV

INTELSAT Series, INSAT, VSAT, Remote sensing, Mobile satellite service: GSM. GPS, INMARSAT, Satellite Navigation System, Direct to Home service (DTH), Special services, E-mail, Video conferencing and Internet connectivity

Text Books:

1. Antenna Handbook by J. D. Kraus

Reference Books:

1. Bruce R. Albert, The Satellite Communication Applications Handbook, Artech House, Boston, 1997

2. Stutzman and Thiele, Antenna Theory and Design, 2nd Ed. John Wiley and Sons. Inc.

3. C. A. Balanis,Antenna Theory Analysis and Design, 2nd Ed. John Wiley

PHY18106DCE **Electronics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Classification of solids based on energy band theory, Mobility and conductivity, Intrinsic Semiconductors Electrons and Holes in the semiconductors. Extrinsic semiconductors – Donor and Acceptor impurities, PN junction – Open circuited, PN junction Diode – Reverse and Forward bias, VI characteristics, Current components in PN diode-Diode current, Reverse saturation current, Majority carrier current components, Current Equations – Diffusion and Drift current, Switching Characteristics of PN Diode.

Unit - II

BJT: Transistor fundamentals, Transistor configuration, Dc operating point, BJT Characteristics and parameters, fixed bias,emitter bias with and without emitter resistance, variation of operating point and its stability.

JFET: Basic structure and operation of JFET, calculation of pinch off voltage, volt-ampere characteristics of JFET, the FET small signal model, FET Biasing, FET as a voltage variable resistor (VVR). MOS structure – MOSFET working – MOSFET characteristics – width of depletion region –junction capacitance-threshold voltage.

Unit - III

Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier – comparison with 741 – Operational amplifier as a open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier: closed loop gain, input impedance, output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain. Applications of op-amp: Linear applications – Phase and frequency response of low pass, high pass and band pass filters(first order), summing amplifier – inverting and non-inverting configurations, subtractor, difference summing amplifier, ideal and practical Differentiator, Integrator.

Unit - IV

Metal semiconductor contacts – ohmic and Schottky contacts., Zener diode , Varactor diode, working principles, characteristics and applications of unijunction transistor (UJT), Silicon control rectifier(SCR): basic structure, modes of operation, Silicon Controlled Rectifier Characteristics,

Principle of operation of photoelectronic devices: photoconductor – efficiency, current gain, response time. Effect of light on I-V characteristics of a junction photo device,principle and working of a photodiode, Light emitting devices, principle , working and factors affecting the efficiency of LED, Solar cell: Working Principle of Solar Cell, Characteristics of a Solar Cell and Parameters of a Solar Cell.

Text Books:

1. Donald A Neaman, "Semiconductor Physics and Devices", Third Edition, Tata Mc Graw Hill Inc., 2007.

Reference Books:

1. Semiconductor Devices Physics and Technology, S M Sze, (2007), John Wiley and Sons Inc. Asia.Solid State Electronic Devices, Ben G Streetman, Sanjay Banerjee, (Fifth edition, 2000), Pearson Education, Asia.
2. Semiconductor Optoelectronic Devices, Pallab Bhattacharya, (Second Edition, 1997), Pearson education, Asia.
3. The art of electronics, Paul Horowitz and Winfield Hill, (Second Edition, 1992), Foundation Books, New Delhi.
4. Electronic Principles, AP Malvino, (Sixth Edition, 1999), Tata McGraw Hill, New Delhi.
5. Op-Amps and Linear Integrated Circuits, Ramakant A Gayakwad, (Third Edition, 2004), Eastern Economy Editio

PHY18107GE **Introduction to Astronomy**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Geometry of the sphere; Celestial Sphere , The cardinal points and circles on the celestial sphere.The alt-azimuth ,equatorial, ecliptic and galactic coordinate systems; Spherical triangle, Twilight, Seasons, Sidereal, Apparent and Mean solar time and their relations, Equation of time, Ephemeris and Atomic Times, Constellations and nomenclature of stars.

Unit - II

Stellar Distances and Magnitudes; Distances of stars by trigonometric parallax method, Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magnitudes and distance modulus. Stellar Classification, H-R Diagram, Black-body approximation to the continuous radiation and temperatures of stars. Variable stars as distance indicators.

Text Books:

1. W. M. Smart, Textbook of Spherical Astronomy
2. K. D. Abhyankar, Astrophysics: Stars and Galaxies, Tata McGraw Hill Publication

Reference Books:

1. A. E. Roy, Orbital Motion
2. McCusky,Introduction to Celestial Mechanics.
3. G. Abhell, Exploration of the Universe
4. A. Unsold, New Cosmos
5. Baidyanath Basu, Introduction to astrophysics

PHY18108GE **Environmental Physics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

These subjects include among other; Natural background radiation, radon, the benefits and risks related to radioactive sources and radioactive pollution, the use of ionizing radiation in medicine and research, nuclear power, fusion, fission, biological consequences of ionizing radiation, radiation induced cancer;

Unit - II

Production and destruction of ozone and the ozone layer, the development of the ozone hole, UV radiation, measurements of ozone and UV radiation, biological effects related to too much and too little UV-exposure, D-vitamin deficiency, skin cancer; The atmosphere and its composition, the greenhouse effect, the role of the greenhouse effect for life on earth,
green house gasses, the variations in the global green house effect and its consequences.

Text Books:

1. Radon in the environment by M. Wilkening, Elsevier Publishing Co.
2. Radon Prevalence, measurement , health risks and control byNiren Laxmichand, Nagda Astm Manual Series, Mnl 5 (1994)
3. Nigel Mason and Peter Hughes: Introduction to Environmental Physics: Planet Earth, Life and Climate, Taylor and Francis, 2001

PHY18109OE **Biophysics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Radiological Physics

Properties of Electromagnetic Radiation, Radiation Units, Exposure and Dose, Dose equivalent Unit, Particle flux, X Rays and Gamma Rays, their interaction with matter, Photoelectric and Compton effect, Ion pair production, Principles of Radiation detection and measurements, General requirement of dosimeters, Telegamma Unit (Cobalt Unit), Radio Isotopes in Biology, Agriculture plant breeding, soil plant relationship and plant physiology, Medicine and diagnosis.

Unit - II

Radiation Safety measures

Natural and manmade Radiation exposure or principle of Dose Equivalent limit (DEL), Maximum permissible Dose (MPD), Evaluation of External and internal Radiation hazards, Radiation protection measures in Industrial establishment, Radio Isotope labs, Diagnostics and therapeutic installations during transportation of Radioactive substances, Disposal of Radioactive waste, Administrative and Legislative aspect of Radiation protection

Text Books:

1. Casarett A.P. (1968), Radiation Biology, Prentice-hall Inc.

2. Clause W.D. (1958), Radiation Biology and Medicine, Addison- Wesley

3. Grosch D.S. (1979), Biological effects of Radiation, Academic Press

4. Howard L. A. (1974), Radiation Biophysics, Prentice Hall Inc.

Reference Books:

1. Knoll G. E., Radiation Detection and Measurement, John Wiley and Sons

Semester - II			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18201CR	Statistical Mechanics	04
	PHY18202CR	Electrodynamics	04
	PHY18203CR	Quantum Mechanics - II	04
	PHY18204CR	Lab. Course	04
Discipline Centric Electives (DCE)	PHY18205DCE	Mathematical Physics - II	04
	PHY18206DCE	Digital Electronics	04
	PHY18207DCE	Fluid Dynamics	04
Generic Electives (GE)	PHY18208GE	Renewable Energy Resources	02
	PHY18209GE	Crystallography	02
Open Electives (OE)	PHY18210OE	Philosophical Foundations of Physics	02

PHY18201CR **Statistical Mechanics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

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,

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.

Text Books:

1. Statistical Physics, Landau and Lifshitz, Butterworth-Heineman, 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. Thermodynamics and Statistical Mechanics by Greiner, Neise and Stocker

PHY18202CR **Electrodynamics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Four Potential Formulation, Equations of motion of charge in electromagnetic field, Gauge invariance, Constant electric field, constant magnetic field and constant electromagnetic field. Electromagnetic field tensor, invariants of the field. Maxwells equations in covariant form, continuity equation, Energy- momentum field tensor.

Unit - II

Constant EM Field: Laplace equation, Boundary Conditions, Methods of Images. Electrostatic energy of charges, The field of a uniformly moving charge, Motion in the Coulomb field, The dipole moment, Multipole moments, System of charges in an external field, Constant magnetic field, Magnetic moments, Larmor's theorem.

Unit - III

EM waves: The wave equation, Plane waves, Monochromatic plane waves, Spectral resolution, Partially polarized light. Reflection and Refraction. Rectangular Waveguide. Propagation through conducting medium.

Unit - IV

The retarded potentials, The Lienard-Wiechert potentials, The field of a system of charges at large distances, Dipole radiation, Dipole radiation during collisions. Quadrupole and magnetic dipole radiation, Synchrotron radiation, Radiation damping.

Text Books:

1. The Classical Theory of Fields, L. D. Landau and E. M. Lifshitz
2. Electrodynamics of Continuous Media,L. D. Landau and E. M. Lifshitz

Reference Books:

1. Classical Electrodynamics byJ. D. Jackson
2. Theory of Charged Particles by Rohrlich

PHY18203CR **Quantum Mechanics - II**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

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 Books:

1. L. I. Schiff, Quantum Mechanics, McGraw Hill, New York, Toronto, London, Kogakush Company Pvt. Ltd. Tokyo

Reference Books:

1. Cohen, Dieu, Laloe, Quantum Mechanics
2. A. P. Messiah, Quantum MechanicsA.
3. J. J. Sakurai, Modern Quantum Mechanics
4. Mathews and Venkatesan, Quantum Mechanics
5. Bjorken and Drell, Relativistic Quantum Mechanics
6. J. R. Atchison, Relativistic Quantum Mechanics
7. Greiner, Relativistic Quantum Mechanics

PHY18204CR **Lab. Course**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **50** External Examination: **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.

List of Experiments

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
- Michelson Interferometer
- Fabry-Perot Interferometer
- Study of Regulated Power Supply
- 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

PHY18205DCE **Mathematical Physics - II**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

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, Newton'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 .

Text Books:

1. Mathematical Methods for Physicists (6th Ed.), G. B. Arfken and H. J. Weber, AcademicPress
2. Mathematical Physics: AModern Introduction to Its Foundations, Sadri Hassani, Springer
3. Intorductory methods of numerical analysis (5^{th} Ed.) S. S. Shastri, PHI Learning Pvt. Ltd.

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

PHY18206DCE **Digital Electronics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Number Systems: Decimal, binary, octal, hexadecimal number system and conversion , binary weighted codes, signed numbers, 1s and 2s complement codes, Binary arithmetic . Boolean Algebra: Binary logic functions , Boolean laws, truth tables, associative and distributive properties, DeMorgans theorems, Implementation of boolean functions using Logic gates, sum of product & product of sums ,Karnaugh Map , two and three variable Karnaugh maps

Unit - II

Digital Logic Gates:Introduction to logic gates:Logic NOT gate (Digital Inverter), Digital Buffer,Logic OR gate, Logic AND gate ,Logic NAND, Logic NOR,Exclusive-OR Gate,Exclusive-NOR Gate,SOP Boolean Function Implementation using logic gates,POS Boolean Function Implementation using logic gates.

Unit - III

Introduction to Combinational Logic Circuits,Binary Adder and Subtractor,Carry look ahead Adder Binary multiplier,Binary encoder,Priority Encoder,Binary Decoder,BCD to 7 segment Display Decoder Multiplexer, Demultiplexer,Digital Comparator,Parity generator/checker Introduction to sequential logic,Latches,Flipflops,SR Flip flop,JK flip flop,D Flip flop,Flip Flop Applications Shift Registers, counters

Unit - IV

Digital integrated circuits: Logic levels , propagation delay time, power dissipation fan-out and fan-in transistor- transistor logic (TTL) gates, output stages, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families.

Text Books:

1. M Morris Mano and Michael D Ciletti , Digital Design (fourth Edition))Robert L. Boylestad & Louis Nashelsky, Electronic Devices & Circuit Theory

Reference Books:

1. Gothmann and William H, Digital Electronics: An introduction to theory and practice
2. Modern Digital Electronics (3rd Ed.) by R. P. Jain

PHY18207DCE **Fluid Dynamics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Introduction to fluid statics and kinematics. Governing Equations of Fluid Motion. Langragian and Eulerian description, Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler's equation, Bernoulli's Equation.

Unit - II

Inviscid Incompressible Flows: Stream function and Velocity potential function, Circulation, Line vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Robins and Magnus effect; Kutta-Joukowski lift theorem.

Unit - III

Concept of lift and drag Compressible Flows: Speed of sound and Mach number, Basic equations for one dimensional flows, Isentropic relations, Normal-shock wave, Oblique shock wave, Prandtl-Meyer expansion waves. Fundamentals of hypersonic flows, Mach number independence, Compressible viscous flows, Compressible boundary layers Viscous

Unit - IV

Incompressible Flows: Couette flows, Poiseuille flows, Creeping flows, Concepts of boundary layer and flow separation.Dimensional Analysis Introduction to dimensional parameters, Buckingham pi theorem, Non-dimensional parameter in fluid mechanics, Modeling and similitude, Flow similarity, Models and prototype, Distorted model.

Text Books:

1. Fox W. Robert, McDonald T. Alan, Introduction to Fluid Mechanics, Fourth Edition, John Wiley & Sons, 1995.
2. Frank M. White, Fluid Mechanics, Tata McGraw-Hill, Singapore, Sixth Edition, 2008.
3. Goldstein J. Richard, Fluid Mechanics Measurements, Second Edition, Taylor & Francis Publication, 1996.

PHY18208GE **Renewable Energy Resources**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

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. Geothermal 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 Bioenergy: Photosynthesis process, Biofuels, Biomass resources Bio based chemicals and materials , Thermochemical Conversion: Pyrolysis, Combustion, Bio fuels: Importance, Production and applications.

Hydrogen Energy

Text Books:

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

2. 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

Reference Books:

1. Energy Systems and Sustainability by Godfrey Boyle

PHY18208GE **Crystallography**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

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 Tilly, Wiley Pub.
2. Introduction to Solid State Physics by Charles Kittel, Wiley Pubb.

Reference Books:

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

PHY18209OE **Philosophical Foundations of Physics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Laws, Explanation and Probability:

The value of laws: Explanation and prediction, Induction and statistical probability, Induction and logical probability, The experimental method.

Measurement and quantitative language:

Three types of concepts in science, The measurement of quantitative concepts, Extensive magnitudes, Time, Length, Derived magnitudes and quantitative language, Merits of quantitative method, The magic view of language.

Unit - II

The structure of space:

Euclid's parallel postulate, Non-euclidean geometries, space in relativity theory, Poincare versus Einstein, advantages of non-Euclidean physical geometry.

Casualty and determinism:

Casualty, Does casualty imply necessity?, The logic of casual modalities, Determinism and free will.

Text Books:

1. Philosophical Foundations of Physics by Rudolph Carnap, Basic Books Foundation, New York

Reference Books:

1. Galileo and Einstein by Michael Fowler, UVa Physics

Semester - III			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18301CR	Nuclear Physics	04
	PHY18302CR	Condensed Matter Physics	04
	PHY18303CR	Atomic Molecular and Laser Physics	04
Discipline Centric Electives (DCE)	PHY18304DCE	Astrophysics - I	02
	PHY18305DCE	Atmospheric Physics - I	02
	PHY18306DCE	Quantum Field Theory - I	02
	PHY18307DCE	Physics of Nano-materials	02
	PHY18308DCE	Superconductivity	02
Generic Electives (GE)	PHY18309GE	Microwave Devices and Circuits	02
	PHY18310GE	Advanced Lab. Methods	02
Open Electives (OE)	PHY18311OE	Lasers	02
	PHY18312OE	Radiation Physics	

PHY18301CR **Nuclear Physics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Nuclear Forces and Two Nucleon Systems: Fundamental Interactions, The deuteron, Deuteron magnetic moment, Deuteron electric quadruple moment, Tensor forces and deuteron D-state, Symmetry and conservation laws, , Pion-Nucleon Interaction, Properties of b Nucleon-Nucleon Force, Yukawa theory of nuclear forces

Unit - II

Bulk Properties of Nuclei: Nuclear size, Rutherford and Mott Scattering, Electron scattering form factor, Charge radius and Charge density, Nucleon Elastic form factors, High energy lepton scattering, Nuclear shape and electromagnetic moments, Magnetic dipole moment of odd nuclei, Ground state spin and isospin, Nuclear binding energy, Semi-empirical mass formulae,

Unit - III

Electromagnetic and Weak Interactions: The Photon-Hadron Interaction:Vector Mesons, The Photo-Hadron Interaction: Real and Space-like Photons, Classical Electromagnetic Interaction, The Continuous Beta Spectrum, Survey of Weak Processes, Weak Interaction and Beta Decay, Nuclear Beta Decay,

Unit - IV

Models of Nuclear Structure: Vibrational Model, Magic number and single-particle energy, Spin-Orbit interaction, Many body basic states, Hartree-Fock single-particle Hamiltonian, Single Particle Shell model, Generalization of Single-Particle Model, Nuclear deformation, Rotational spectra of spinless Nuclei, Fermi gas model.

Text Books:

1. Introductory Nuclear Physics by Samuel S. M. Wong, Wiley-VCH

Reference Books:

1. Introductory Nuclear Physics, Kenth S. Krane, WIley, New York, 1987
2. Atomic and Nuclear Physics, S. N. Ghoshal
3. Introduction to Nuclear Physics, H. A. Enge, Addison-Wesley, 1982

PHY18302CR **Condensed Matter Physics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Crystal lattice; crystal planes and directions. Crystal symmetry, crystallographic point groups and their applications. Space groups, Direct and reciprocal lattice. Diffraction of waves by Crystals, scattered wave amplitude, Fourier Analysis of a crystal. Reciprocal lattice and its applications to diffraction techniques, Diffraction conditions in reciprocal space, Brillouin zones, Crystal structure factor and atomic scattering factor.

Unit - II

Quantum mechanical free electron model, Density of state function, Electrons in a periodic lattice, origin of energy gaps. Bloch theorem, Bloch modes, Schrodinger wave equation in a reciprocal space; Tight binding approximation. Fermi surface of solids; experimental methods, De Hass-van Alfen effect, Cyclotron resonance, Electron motion in a uniform magnetic field, Landau Levels. Electronic structure of a two dimensional electron gas, Integral quantum Hall- effect.

Unit - III

Low dimensional electron systems: One dimensional systems; DOS, 1D sub-bands, Van-Hove singularities and their applications. Conductance quantization and the Landauer formalism. Resonant tunnelling, two potential barriers in series.

Zero dimensional systems: quantized energy levels of semiconductor nano-crystals, DOS. Metallic dots, discrete charge states, Coulomb Blockade, Single Electron devices.

Unit - IV

Ferromagnetism: Weiss theory of ferromagnetism, Curie-Weiss law for susceptibility Heisenberg model and molecular field theory. Spin waves and Magnons, Bloch $T^{3/2}$ law. Formation of Domains, Bloch-wall energy.

Ferroelectricity: Classification of Ferroelectric Crystals, Landau theory of the ferroelectric phase transition. Soft mode theory. applications of ferroelectric materials.

Text Books:

1. Introduction to Solid State Physics, Charles Kittel, John Wiley and Sons
2. The physics of low dimensional semiconductors: An introduction by John H. Davis, Cambridge University Press.
3. Quantum mechanics for nanostructure by Cladimir Mitin, Dmitry Sementsov, Nizami Vagidov, Cambridge University Press.

Reference Books:

1. A modern course in quantum theory of solids by Fuxuang Han, Wiley Scientific.
2. Solid state physics by Neil W. Ashcroft and N. David Mermin, Black Well Pub.

PHY18303CR **Atomic Molecular and Laser Physics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

One-electron atoms: Fine structure of hydrogenic atoms. Energy shifts, The Lamb shift, Hyperfine structure, Zeeman effect, weak and strong fields-Paschen-Back effect, Stark effect (linear and quadratic).

Two-electron atoms: The Schrodinger equation for two-electron atoms, Spin wave functions and the role of the Pauli exclusion principle, The independent particle model: The ground state of two-electron atoms.

Unit - II

Many-electron atoms: The central field approximation, Spin-orbitals and Slater determinants. The Thomas-Fermi model of the atom, The Thomas-Fermi Theory of multi-electron atoms, Introduction to Hartree-Fock method .

Correlation effects, L-S coupling and j-j coupling: Possible terms of a multi-electron configuration in L-S coupling, Fine structure of terms in L-S coupling, Lande interval rule.

Unit - III

Molecular structure: The Born-Oppenheimer separation for diatomic molecules. The rotation and vibration of diatomic molecules, Rotational spectra of diatomic molecules: Vibrational and vibrational-rotational spectra of diatomic molecules, Raman Effect: quantum mechanical theory of Raman Effect, Rotational and Vibrational-Rotation Raman Spectroscopy.

Unit - IV

Absorption, spontaneous and stimulated emission. Einstein coefficients, Transition probability and lifetime of an atom in an excited state. Population inversion. Laser rate equations: The three level and four level systems. Line broadening mechanism. Shape and width of spectral lines. Optical resonators: Quality factor. Losses inside the cavity. Threshold conditions. Schawlow- Townes condition. Transverse and longitudinal mode selection. Laser Systems He-Ne laser. CO_2 laser. Four level solid state lasers. Properties of laser beam: directionality, monochromacity, intensity, coherence (temporal and Spatial).

Text Books:

1. Physics of atoms and molecules by B. H. Brandsen and C. J. Joachim, 2nd Ed.
2. Spectra of atoms and molecules by Peter F. Berth, Oxford University Press
3. Atoms and Molecules by Mitchel Weissbluth

Reference Books:

1. Fundamentals of molecular spectroscopy by C. B. Banwell
2. Introduction to molecular spectroscopy by G. M. Barrow
3. Modern spectroscopy, J. M. Holias

PHY18304DCE **Astrophysics - I**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Spectral classification, Stellar distances, Absolute magnitude and sistance modulus, The H-R diagram of stars.

Stellar interiors: Equation of conservation of mass, hydrostatic equilibrium, thermal equilibrium and energy transport. Equation of state, Stellar opacity, Stellar Energy Sources. Application of virial theorem to isothermal spheres, Polytropic model, Lane-emden's equation, Central temperature and pressure,

Unit - II

Evolution of stars, interstellar dust and gas, Jean's criteria for stability, formation of stars, Evolution of stars on the basis of HR-diagram, Binary stars, masses of binary stars, Fate of massive stars, Supernovae, White dwarfs, Chandrashekhar limit, neutron stars, Pulsars, black holes.

Text Books:

1. Stellar evolution by Chandrashekhar
2. Modern astrophysics by B. W. Caroroll and D. A. Ostlie, Addison-Wesley Pub.

Reference Books:

1. Astronomy by R. H. Baker
2. Exploration of universe by G. Abell

PHY18305DCE **Atmospheric Physics - I**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Origin, Composition and Mean Structure of the Atmosphere, Vertical profiles of pressure and density, Variable constituents, The vertical temperature structure, General Circulation of the Atmosphere, Energy Balance of the Earth, Global Patterns of Insolation , Heating Imbalances, Earth's Energy Budget, Surface Energy Budget

Modeling Energy Balance, Global Heat Balance, Atmosphere's Energy Budget, Natural Greenhouse Effect, Effect on Surface Temperature

Unit - II

Gas law and its application to dry air, water vapour, and moist air, Virtual Temperature, Hydrostatic Equation ,Geopotential, Scale Height, hypsometric equation, Reduction of Pressure to Sea Level, specific heat, adiabatic and isothermal processes, concept of air parcel, dry adiabatic lapse rate, potential temperature, first law thermodynamic applied to atmosphere, Moisture Parameters, potential temperature, Clausius Clapeyron equation, latent Heats, Saturated Adiabatic and Pseudo adiabatic Processes, The Saturated Adiabatic Lapse Rate, Equivalent Potential Temperature and Wet-Bulb Potential Temperature, Stability and instability

Text Books:

1. McIlveen R., Fundamentals of Climate, Chapman Hall, 1992
2. J. R. Holton, An introduction to dynamic metreology, 3rd Ed.

Reference Books:

1. The Physics of atmospheres by J. T. Houghton, 1986
2. Theory of satellite orbit in the atmosphere by King Hele
3. Weather satellite by L. F. Hubert
4. Meteorological satellite by W. K. Hedger
5. A guide to earth satellite by D. Fishlock

PHY18306DCE **Quantum Field Theory- I**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Relativistic Wave Equations: Klein-Gordon equation. Dirac equation, SU(2) and the rotation group; SL(2,C) and the Lorentz group. Prediction of antiparticles. Non-relativistic limit and Electron magnetic moment.Construction of Dirac spinors: algebra of γ- matrices. Lagrangian formulation and Noether's theorem.

Unit - II

Canonical quantisation and particle interpretation: The real Klein-Gordon field. The complex Klein-Gordon field. The Dirac field. The electromagnetic field. Radiation gauge quantisation. Lorentz gauge quantisation. PCT symmetries, Symmetry Breaking and Higgs Mechanism.

Text Books:

1. A first book of quantum field theory, Lahiri and Pal, Narosa Publishing House
2. Quantum field theory, Lewis H. Ryder, Cambridge University Press

Reference Books:

1. Bjorken and Drell, Relativist quantum fields
2. Itzyken and Zubair, QUantum Field Theory
3. Weather satellite by L. F. Hubert
4. Meteorological satellite by W. K. Hedger
5. A guide to earth satellite by D. Fishlock

PHY18307DCE **Physics of nanomaterials**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Introductory aspects: Overview of nanomaterials, definition of nanomaterials based on Bohr radius, de-Broglie wavelength, Exciton radius, Surface to volume ratio, Estimation of number of atoms in nanostuctures, ExcitonS, Confinement Regimes , Metallic and Semi conducting nanomaterials, Fermi Energy, Fermi Velocity, Kubo Gap, Density of state for bulk materials, Density of states for Quantum well, Quantum wire and Quantum Dots, Examples of nanomaterials

Unit - II

Preparation of Nanomaterials and General Characterization Techniques. Bottom up: Thermal Evaporation techniques, Sputtering technique, Pulsed Laser Deposition Technique, ion beam deposition, Top down: Ball Milling

Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Atomic Force Microscope(AFM),X-ray Diffraction Technique,,Spectroscopies (UV-Vis, IR, FTIR and Raman), Vibrating Sample Magnetometer (VSM)

Text Books:

1. Introductory nanoscience: physical and chemical concepts: Masaru Kuno, Garland Science.
2. Nanotechnology noleculary designed materials: G. M. Chow and K. E. Gonsalves, American Chemical Society.
3. Nanotechnology: Molecular speculations on global abundance: B. C. Crandall (MIT Press)
4. Nanotechnology: Principled=s and practices, Sulubha K. Kulkarni (Capital publishing company)

Reference Books:

1. Qantum dot hetereostructure, D. Bimerg, M. Grundamann and N. N. Ledontsov, Wiley.
2. Nanoparticle and nanostructure film preparation, characterisation and application: J. H. Fredler (Wiley)

PHY18308DCE **Superconductivity**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

The superconducting state, Basic properties of the superconducting state: Zero resistance, Critical temperature, The Meissner effect (Perfect diamagnetism), Flux quantization, Isotope effect, Critical magnetic fields, Type-I and Type-II superconductors, Critical Current, Penetration depth, Coherence length, Thermodynamics of transition, First and Second order transitions, Entropy, specific heat, Energy gap, The Josephson effects.

Unit - II

Models and theories: Two fluid model, London equations, Ginzburg-Landau theory, main results of Bardeen Cooper and Schrieffer (BCS) theory: Instability of the Fermi Surface in the presence of attractive Interaction between electrons, Electron distribution in the ground state of a Superconductor, Critical temperature, Energy gap, Origin of the attractive interaction. Introduction to Hi T_C superconductivity.

Applications: SQUIDS, Magnetic Shielding, Power Transmission, Energy Storage devices, and Medical Applications.

Text Books:

1. A. C. Rose-Innes, Introduction to superconductivity (Pregamon Press)

Reference Books:

1. C. P. Poole, Handbook of superconductivity (Academic Press 2000)
2. Andre Mourchakine, Room temperature superconductivity (Cambridge 2004)
3. Jeffery W. Linn, High temperature superconductivity (Springer Verlag 1990)
4. T. V. Rama krishnan and C. N. Rao, Superconductivity today (Wiley 1992)
5. M. Tinkham, Introduction to superconductivity (McGraw Hill, 2004)

PHY18309GE **Microwave Devices and Circuits**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Introduction to microwaves and applications, advantages of microwaves, EM spectrum domain, electric and magnetic fields static electric and magnetic fields, time varying electric and magnetic fields, Microwave Tubes: Limitation of conventional tubes, microwave tubes, velocity modulation, method of producing the velocity modulation, principle of operation of two cavity klystron, reflex klystron principle of operation, velocity modulation in reflex klystron

Unit - II

Microwave Semiconductor Devices: Microwave bipolar transistor, FET, Principle of Operation and application of tunnel diode, Principle of operation of gun diode, application of gun diode advantages of gun diode, principle of operation of PIN diode and applications, Tunnel diode, IMPATT, TRAPATT Diodes

Text Books:

1. Microwave devices and circuits by S. Y. Liao

Reference Books:

1. Microwave engineering by S. N. Raju, IK International Publishers 2007
2. Microwave engineering by P. A. Rizzi, PHI, 1999
3. Microwave engineering, Non-reciprocal active and passive circuits by Joseph Helszajin, McGraw Hill, 1992

PHY18310GE **Advanced Lab. Methods**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Types of Radiation, Radiation Detector, General Detector Properties, Geiger Counters ,Scintillator Detectors , Solid State (Semiconductor) Detectors , Specific Models: Binomial Distribution, Poisson Distribution Gaussian (Normal) Distribution. Properties of the Binomial Distribution, Poisson Distribution and Gaussian (Normal) Distribution. Examples. Error Propagation Formula, Sums or Differences of Counts, Multiplication or Division of Counts, Limits of Detection.

Unit - II

Lab Procedures

Existence of Radiation:Become familiar with different sources of radiation around us, and measure the level of radiation emitted from them.

Gamma-Ray Spectroscopy using NAI(Tl):Basic techniques used for measuring gamma rays, based on the use of a sodium iodide (NaI) detector that is thallium-activated (Tl). Spectrum Analysis of ^{60}CO and ^{137}CS explain some of the features other than the photo peaks, that are usually present in a pulse-height spectrum. These are the Compton edge, backscatter peak, and x- rays.

Mass Absorption Coefficient :To measure experimentally the mass absorption coefficient in lead and other materials like iron Aluminium with sources Na-22, Cs.

Text Books:

1. Radiation detection and measurement by Glenn F. Knoll

Reference Books:

1. Physics of radiation detection and measurement by Syed Nayeem Ahmad
2. Practical gamma ray spectroscopy by Gordon Gilmore
3. The design and construction of NaI(Tl) scintillation detector by Samuel Trit.

PHY18311OE **Lasers**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Absorption, spontaneous and stimulated emission. Einstein coefficients, Transition probability and lifetime of an atom in an excited state. Population inversion. Laser rate equations: The three level and four level systems. Line broadening mechanism. Shape and width of spectral lines. Optical resonators: Quality factor. Losses inside the cavity. Threshold conditions. Schawlow- Townes condition. Transverse and longitudinal mode selection.

Unit - II

Laser Systems He-Ne laser. CO_2 laser. Four level solid state lasers. Dye lasers. Ar+ laser. Excimer lasers. Properties of laser beam: directionality, mono chromacity, intensity, coherence (temporal and Spatial). Applications oflasers: Laser induced fusion. Isotope separation.

Text Books:

1. Lasers: theory and applications by K. K. Thyagarajan and A. K. Ghatak
2. Laser and non-linear optics, B. B. Laud

PHY18312OE **Radiation Physics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Dosimetric concepts and quantities:

Electromagnetic Radiation, Ionizing and Non Ionizing Radiation, Radiation Units, Exposure and Dose, Dose equivalent Unit, Particle flux, X Rays and Gamma Rays, their interaction with matter, Photoelectric and Compton effect, Exposure-Roentgen - photon fluence and energy fluence, Kerma and absorbed dose, stopping power - relationship between the dosimetric quantities, Safety measures, Radiation Protection laws.

Unit - II

Principles of radiation detection:

Radiation monitoring – Area survey meters – Ionization chambers – proportional counters – neutron area survey meters – GM survey meters – scintillation detectors – Personal monitoring – film badge – TLD .

Properties of personal monitors - Radiophtoluminesce glass dosimetry system - OSLD. Principles of Radiation detection – properties of dosimeters - Theory of gas filled Detectors.

Text Books:

1. The physics of radiation therapy by F. M. Khan, 3rd Ed. Lippincott Williams and Wilkins, USA, 20003

Reference Books:

1. The Physics of radiology by H. E. Jones and J. R. Cunnigham, Charles C. Thomas, New York 2002
2. Fundamental physics of radiology by W. J. Meredith and J. B. Massey, John Wright and Sons UK, 2002
3. Medical radiation physics by W. R. Handee, Yearbook medical publishers Inc. London, 2003

Semester - IV			
Type of Course	**Course Code**	**Title of Course**	**No. of Credits**
Core (CR)	PHY18401CR	Particle Physics	04
	PHY18402CR	Computational Methods in Physics	04
	PHY18403CR	Project	04
Discipline Centric Electives (DCE)	PHY18404DCE	Astrophysics - II	02
	PHY18405DCE	Atmospheric Physics - II	02
	PHY18406DCE	Quantum Field Theory - II	02
	PHY18407DCE	High Energy Physics	02
	PHY18408DCE	Neutrino Physics	02
	PHY18409DCE	General Relativity	02
Generic Electives (GE)	PHY18410GE	Modern Communication Systems	02
	PHY18411GE	Astronomical Techniques	02
Open Electives (OE)	PHY18412OE	Atmospheric Science	02

PHY18401CR **Particle Physics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Overview of Elementary particles: Overview of particle discoveries, particle classification schemes, the Gellmann-Nishijima scheme, the eight fold way, the quark model.

Invariance principles and conservation laws: the parity operation, parity of particles and antiparticles, tests of parity conservation, charge conjugation invariance, charge conservation and gauge invariance, baryon and lepton conservation, CPT invariance, CP violation.

Unit - II

Weak Interactions: V-A theory, coupling constant, neutron decay, muon decay, pion decay, CP invariance and violation, Charged weak interactions, neutral weak interactions, Cabibo mixing, CP violation; the neutral kaon system.

Electroweak Interactions: prediction and discovery of W/Z , weak isospin and hypercharge, the basic electroweak interaction, the effective current-current interaction, Feynman rules for electroweak interaction, Electron-positron annihilation

Unit - III

Quark structure of hadrons: the baryon decouplet, quark spin and colour, the baryon octet, magnetic moment of baryons, the light pseudoscalar mesons, the light vector mesons, mesons built of heavy quarks.

Lepton and quark scattering: electron positron annihilation to hadrons. electron-muon scattering, neutrino-electron scattering, lepton-nucleon scattering, deep inelastic scattering and quarks.

Unit - IV

Strong Interactions: the evidence for quarks and colour charge, strange particles, strongly decaying resonances.

Standard model: particle content of the Standard Model, nature of fundamental interactions, Inadequacies of SM, unification of electroweak and strong interactions

Text Books:

1. Introduction to elementary particles by David J. Griffiths, John Wiley and Sons.
2. Quarks and Leptons by F. H. Halzen and J. D. Martin, John Wiley and Sons.

Reference Books:

1. Introduction to high energy physics by D. H. Perkins

PHY18402CR **Computational Methods in Physics**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** External Examination: **80**

Unit - I

Computers, Interpreters and Operating system, Types of programming languages, C programming, Programme Characteristics, C character set, identifiers and key words, Data types, Constants, Variables and Arrays Declaration, Expressions, Statements, Symbolic constants, Operators and Expressions, Library functions, Data input and output, Error Diagnostics, Debugging Techniques, Control statements, Case studies, Programming exercises

Unit - II

Arrays, Character Arrays and Strings, User defined functions, Function properties, Recurrsion, Programme Structure, Structure and Unions, Pointers, Pointer Declaration, Operation on pointers, Pointers and one dimensional arrays, Arrays of pointers, User defined data types, File management in C, Preprocessor, Guidelines for developing a C programme, Case studies, Programming exercises

Unit - III

Developing algorithms and Computer programs in C-Language to solve following problems:

(1) Linear Equations
(2) Non-Linear Equations
(3) Matrix Inversion
(4) Eigen-Values and Eigen-Vectors

Unit - IV

Developing algorithms and Computers programs in C-Language to solve following problems:

(1) Interpolation with equally spaced and unequally spaced points
(2) Cubic Spline fitting
(3) Numerical Differentiation and Integration
(4) Second order differential equation by Runge-Kutta method and other methods

Text Books:

1. Introductory methods of numerical analysis by Sastry
2. Numerical analysis by Rajaraman
3. Numerical recipes by Press Teukolsky Vetterming and Flannery.
4. Programming in ANSI C, Balaguruswamy

Reference Books:

1. Numerical analysis by Rajaraman

PHY18403CR **Project**

No. of Credits: **04** Max. Marks: **100**

Internal Assessment: **20** Dissertation/Tour/Presentation/Viva-voce: **80**

Description

The students will work intensively on a topic of her/his choice, while interacting on regular basis with the project supervisor. The project should consist of any innovative topic in Physics which, in principle, should lead to some training for further research on the topic. The student should present the most recent and novel research happenings in the field.

The curriculum shall consist of the preparation and submission of a project report and then oral presentation and viva-voce before a committee consisting of internal and external examiners. The distribution of marks for the various component of this curriculum shall be as follows;

Total Marks:	**100**
Internal Assessment (By Sipervisor):	20
Contents of Project Report:	20
Tour:	10
Presentation/Viva-voce (External):	50

PHY18404DCE **Astrophysics - II**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

The Milky Way galaxy, size and shape, rotation curve of galaxy, radio observation and spiral structure, star counts, interstellar extinction. Hubble classification of galaxies.
Stellar dynamics, types of forces on a star in the stellar system, Tidal radii, star star encounter, time of relaxation determination of time of relaxation, application to Galaxy & star cluster. Masses of double galaxies, Masses of cluster of galaxies by virial theorem observational determination of masses, clusters of galaxies, Missing mass problem.

Unit - II

Cosmology, cosmological principle, Newtonian cosmology, deceleration parameters critical density, Robertson walker equation and its properties, solution of Robertson-Walker equations. Einstein field equation in cosmology, Energy tensor of Universe, solution of Friedman's equation, Einstein de-sitter model, open model, particle horizon, Event horizon.Thermal History of the Universe, Temperature red shift relation, distribution in the early Universe, relativistic and non-relativistic limits, decoupling of matter and radiation, Cosmic microwave background radiation (CMBR)

Text Books:

1. Introduction to Cosmology by J. V. Narlikar
2. Modern astrophysics by B. W. Caroroll and D. A. Ostlie, Addison-Wesley Pub.

Reference Books:

1. Structure foundation in universe by T. Padmanabhan, Cambridge University Press
2. Stellar dynamics by S. Chandrashekhar
3. Stellar evolution by Kippenhahn
4. Quasars and active galactic nuclei by A. K. Kembhavia and J. V. Narlikar. Cambridge University Press.

PHY18405DCE **Atmospheric Physics - II**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Earth coordinate system (latitude, longitude, depth),Dynamic and thermodynamic variables (u,v,w,T,P,density).Forces felt by an air parcel, mathematical development of apparent forces, momentum equations,scale analysis momentum equations, the Rossby Number and geostrophic, Cyclostrophic and gradient Balance, Continuity equation, Energy equation ,Governing equations for synoptic scale.The Thermal Wind, Vertical motion, pressure coordinates,Basic equations in pressure coordinates.

Unit - II

Weather and climate, weather forecasting, Numerical weather prediction models, Global climate models, Working principle, application and circuit descriptions in blocks of the system: Ionosonde, Rdiosonde, Ozonesonde, LIDARS, DIAL, SODARS, AWS, weather Satellites, Doppler Radar, ST Radar and MST radar

Text Books:

1. McIlveen R., Fundamentals of Climate, Chapman Hall, 1992
2. J. R. Holton, An introduction to dynamic metreology, 3rd Ed.

Reference Books:

1. The Physics of atmospheres by J. T. Houghton, 1986
2. Theory of satellite orbit in the atmosphere by King Hele
3. Weather satellite by L. F. Hubert
4. Meteorological satellite by W. K. Hedger
5. A guide to earth satellite by D. Fishlock

PHY18406DCE **Quantum Field Theory- II**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

The S-matrix expansion: Examples of interactions , Evolution operator, S-matrix. Wick's theorem. Feynman diagrams and Rules: Yukawa interaction: decay of a scalar. Cross section for QED processes: Electron-electron scattering. Consequence of gauge invariance. Compton scattering, Scattering by an external field. Bremsstrahlung.

Unit - II

Electromagnetic form factors: General electromagnetic vertex, Physical interpretation of form factors . Renormalization : Degree of divergence of a diagram, Regularization of self- energy diagrams, Counterterms, Ward-Takahashi identity. Observable effects of renormalization.

Text Books:

1. A first book of quantum field theory, Lahiri and Pal, Narosa Publishing House
2. Quantum field theory, Lewis H. Ryder, Cambridge University Press

Reference Books:

1. Bjorken and Drell, Relativist quantum fields
2. Itzyken and Zubair, QUantum Field Theory
3. Weather satellite by L. F. Hubert
4. Meteorological satellite by W. K. Hedger
5. A guide to earth satellite by D. Fishlock

PHY18407DCE **High Energy Physics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Particle Classification: Fermions and bosons, particles and antiparticles, free particle wave equation, lepton flavours , quark flavours.

Interactions and fields: Classical and quantum picture of Interactions, Yukawa theory of quantum exchange.

Parity Operation, test of parity conservation, charge conjugation Invariance, baryon and lepton conservation, isospin in pion-nucleon systems,

Unit - II

Quarks and Gluons, Bag model of hadrons, Quark Gluon Plasma, Quark Gluon Plasma at High Temperature, Quark Gluon Plasma with High Baryon Density, J/Psi suppression and production in Quark Gluon Plasma, Dilepton production in QGP, Photon production on Quark Gluon Plasma, Experimental information on J/Psi production and suppression, Experimental information on photon production.

Text Books:

1. Introduction to high energy heavy ion collisions, Cheuk Yen Wong

Reference Books:

1. Introduction to high energy physics by D. H. Perkins

PHY18408DCE **Neutrino Physics**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Introduction and Historical Overview, motivation for proposing the neutrino, first discovery by Reines and Cowan and subsequent discoveries, the number of neutrinos, neutrino properties and interactions, neutrino electron elastic scattering, neutrino-nucleon quasi-elastic scattering, neutrino-nucleon deep inelastic scattering, solar neutrinos, atmospheric neutrinos, terrestrial neutrino sources

Unit - II

Neutrino mass, neutrino oscillations, flavour oscillations in vacuum and matter, solution of the solar and atmospheric problems, limitations of oscillation experiments, direct mass searches, kinematic mass determination, double beta decay, summary of understanding now, outstanding questions and the future of experimental neutrino physics

Text Books:

1. Neutrino Physics by Kai Zubair, CRC Press
2. Current aspects of neutrino physics. Ed. by David O. Codwell, Springer Publications

Reference Books:

1. Fundamentals of neutrino physics and astrophysics by Carlo Giunti and Chung W. Kim

PHY18409DCE **General Theory of Relativity**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Principle of general covariance. Tensor Calculus Vector and tensor fields, Parallel transport. Connection coefficients. Metric tensor. Covariant derivative. Geodesic equation, Gravity in Simple Situations Motion along a geodesic. Riemann curvature tensor. Symmetry properties of Riemann tensor. Bianchi identity. Ricci and Einstein tensor.

Unit - II

Einstein equation, Solutions of Einstein equations, Einstein equation in vacuum, Schwarzschild solution, Schwarzschild solution extension in Kruskal-Szekeres coordinates. Energy momentum tensors, energymomentum tensor for a perfect fluid. Action principle for gravitational and matter fields. Kerr solution. Black holes. Gravitational waves.

Text Books:

1. Gravitation and cosmology: Principles and applications of GTR, S. Weinberg, Wiley
2. General theory of relativity, J. B. Hartle (Cambridge Press)

Reference Books:

1. Space time geometry by Sean Carrol, Cambridge University Press
2. General relativity by G. Wald,Cambridge University Press
3. Gravitation, foundations and frontiers by T. Padmanabhan

PHY18410GE **Modern Communication Systems**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Introduction to wireless communications, example of wireless communication system, the Cellular concept and system design fundamentals, frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, trunk and grade services, Methods for improving coverage and capacity in cellular system,

Multiple access techniques for wireless communications FDMA, TDMA, Spread spectrum techniques, SDMA, Packet Radio, CSMA, Capacity of cellular CDMA with multiple cells and capacity of SDMA

Unit - II

Wireless systems and standards, AMPS, IS-94, GSM traffic, Examples of GSM cell, frame structure of GSM cello, details of forward and reverse CDMA channels

Personal access communication systems, Personal Mobile satellite communication, Integrating GEO, LEO, MEO Satellite and terrestrial mobile systems, Rake receiver and Advanced Rake receiver

Text Books:

1. Wireless communication, principles and practice, 2nd Ed., Theodore S. Reppaport
2. Wireless digital coomunicatio, Kamilo Feher

Reference Books:

1. Electronic communication systems by Wayne Tomasi

PHY18411GE **Astronomical Techniques**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Telescopes; Types of telescopes. Design and construction of a simple Optical telescopes. Schmidt telescopes. Sky charts and their importance. Solar telescopes. Detectors for optical and infrared regions. Application of CCD's to stellar imaging.

Unit - II

Astronomical photometry; Simple design of an astronomical photometer. Observing technique with a photometer Correction for atmospheric extinction. Tansformation to a standard photometric system. Astronomical spectroscopy; Spectral classification. Simple design of astronomical spectrograph. Radial velocity measurements.

Text Books:

1. C. R. Kitchin: Astrophysical Techniques
2. Heindren and Kaitchuck: Astronomical photometry

Reference Books:

1. Gordon Walker: Astronomical observations - an optical perspective, Cambridge university press.
2. Astrophysics - stars and galaxies by K. D. Abhyankar
3. C. R. Miczaika and W. M. Sinton: Tools of the astronomers
4. W. A. Hiltner: Astronomical techniques
5. Carelton: Methods of experimental physics. Vol XII A

PHY18412OE **Atmospheric Science**

No. of Credits: **02** Max. Marks: **50**

Internal Assessment: **10** External Examination: **40**

Unit - I

Introduction to Atmospheric Sciences, the physical, chemical and dynamical processes of the troposphere. The governing conservation (balance) equations for trace constituents, dry air, water substances, total mass (equation of continuity), energy (1^{st} law of thermodynamics), entropy (2^{nd} law of thermodynamics), and momentum equations, Introduction to cloud science, Formation of clouds and their distribution. Monsoons and their formation as well as their distribution. Fundamentals of biogeochemical cycles (e.g., CO_2, H_2O, nitrogen, etc.) and the origin of the ozone layer

Unit - II

Radiations in Atmosphere- radiation includes solar and terrestrial radiation, major absorbers, radiation balance, radiative equilibrium, radiative-convective equilibrium, basics of molecular, aerosol, and cloud adsorption and scattering. Satellite imaginary, greenhouse gases (e.g., CO_2, H_2O, CH_4, etc.), and optical phenomena like rainbows, halos etc. Interactions of the global energy, water, and trace gas cycles and their influence on general circulation and their role in the climate system. Numerical modelling of atmospheric and hydro-meteorological processes.

Text Books:

1. Lectures in meteorology by Molders M, Kramm G., Springer atmospheric series
2. McIlveen R., Fundamentals of weather and climate, Chapmann-Hall

Reference Books:

1. The Physics of atmospheres by J. T. Houghton, 1986
2. Theory of satellite orbit in the atmosphere by King Hele
3. Weather satellite by L. F. Hubert