

SYLLABUS

For

Choice Based Credit System

(CBCS)

With

Outcome Based Education

(OBE)

Two Year M.Sc. Programme
in Physics

PAT NA WOMEN'S COLLEGE

Autonomous

PATNA UNIVERSITY

3rd Cycle NAAC Accredited at 'A' Grade with CGPA 3.58/4

"College with Potential for Excellence" (CPE) Status Accorded by UGC

VISION

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a centre of academic excellence in higher education, social responsibility, and empowerment of women.

MISSION STATEMENT

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a center of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value-based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value-based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

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PROGRAM OUTCOMES (PO)

The recent developments in Physics, has been included in the enriched M.Sc. (Physics) Syllabus to meet the present day needs of Academic and Research Institutions and Industries. An important objective of the course is to develop an understanding of “core physics” at deeper levels, each stage revealing new phenomena and greater insight into the behavior of matter and college and university level physics to bring all students to a common point. These courses also aim to consolidate the college level knowledge of physics by providing much more logical and analytical framework which will be essential for the specialization courses in the this and fourth semesters. After the completion of their M.Sc., Students will have

PO1: Strong analytical abilities.

PO2: Qualities needed for teaching of science and doing research.

PO3: Knowledge of theoretical as well as experimental areas of Physics.

PO4: Capabilities to generate self-employment.

PO5: Computational Skill and ICT development.

PROGRAM SPECIFIC OUTCOMES (PSO)

Upon completion of the program, the students will attain the ability to:

PSO1: Acquire fundamental knowledge in physics, including the major premises of classical mechanics, quantum mechanics, electromagnetic theory, electronics, optics, special theory of relativity and modern physics.

PSO2: Develop a written and oral communication skill in communicating physics-related topics.

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PSO3: Design and conduct an experiment (or series of experiments) demonstrating their understanding of the scientific method and processes. Not only that they are expected to have an understanding of the analytical methods required to interpret and analyze results and draw conclusions as supported by their data.

PSO4: Learn the applications of numerical techniques for modelling physical systems for which analytical methods are inappropriate or of limited utility.

PSO5: Develop an understanding of the impact of physics and science on society.

PSO6: Apply conceptual understanding of the physics to general real-world situations.

Also, discover of physics concepts in other disciplines such as mathematics, computer science, engineering, and chemistry.

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SUMMARY OF SYLLABUS

M.Sc. Physics

Note: 1 Credit = 15 Hours

1. Theory paper: 5 credits each (4 Theory and 1 Tutorial).
2. Tutorial group of each theory paper should have a group size of 8 students.
3. Practical paper will not have tutorials.

Core Courses (5 Credits each)

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

Skill Enhancement Course (SEC) (2 Credits)

Skill Enhancement Courses (SEC): These courses may be chosen from a pool of courses designed to provide **value-based and/or skill-based knowledge**.

Discipline Specific Elective (DSE) (5 Credits each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Generic Elective Papers (GE) (5 Credits each)

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective.

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SEMESTER – I: M.Sc. PHYSICS

COURSE OPTED	COURSE CODE	COURSE NAME	CREDITS
CC – 1 (Core Course)	MPHY-CC101	Mathematical Physics	05
CC – 2 (Core Course)	MPHY-CC102	Classical Mechanics	05
CC – 3 (Core Course)	MPHY-CC103	Electrodynamics and Plasma	05
CC – 4 (Core Course)	MPHY-CC104	Physics Laboratory – I	05
AECC – 1 (Ability Enhancement Compulsory Course)	MAECC101	Environmental Sustainability Swachcha Bharat Abhiyan Activities	03 02

SEMESTER – II: M.Sc. PHYSICS

COURSE OPTED	COURSE CODE	COURSE NAME	CREDITS
CC – 5 (Core Course)	MPHY-CC205	Numerical Analysis and Simulation	05
CC – 6 (Core Course)	MPHY-CC206	Quantum Mechanics	05
CC – 7 (Core Course)	MPHY-CC207	Electronics	05
CC – 8 (Core Course)	MPHY-CC208	Atomic and Molecular Spectroscopy and Laser	05
CC – 9 (Core Course)	MPHY-CC209	Physics Laboratory – II	05
SEC – 1 (Skill Enhancement Course)	MPHY-SEC201	A. Physics and Workshop Training B. Web designing C. Cookery and Bakery D. Solid Waste Management E. Environmental Law F. Life-Skill and Skill Management	05

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SEMESTER – III: M.Sc. PHYSICS

COURSE OPTED	COURSE CODE	COURSE NAME	CREDITS
CC – 10 (Core Course)	MPHY-CC310	Statistical Mechanics	05
CC – 11 (Core Course)	MPHY-CC311	Condensed Matter Physics	05
CC – 12 (Core Course)	MPHY-CC312	Nuclear and Particle Physics	05
CC – 13 (Core Course)	MPHY-CC313	Biophysics	05
CC – 14 (Core Course)	MPHY-CC314	Physics Laboratory – III	05
AECC – 2 (Ability Enhancement Compulsory Course)	MAECC302	Human Values & Professional Ethics Gender Sensitization	03 02

SEMESTER – IV: M.Sc. PHYSICS

COURSE OPTED	COURSE CODE	COURSE NAME	CREDITS
DSE – 1 (Discipline Specific Elective Course)	MPHY-DSE-401	A. Plasma Physics B. Nano Science C. Laser and Photonics D. Advanced Electronics E. Crystal Physics and X-ray Crystallography F. Environmental Physics	05
DSE – 2 (Discipline Specific Elective Course)	MPHY-DSE-402	Dissertation / Project work / Internship	05
GE – 1 (Generic Elective Course)	MPHY-GE-401	Renewable Energy and Energy Harvesting	05

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PHYSICS (M.SC.) DETAILS OF CBCS SYLLABUS

SEMESTER – I

Core Courses (5 Credit Each)

MPHYCC – 101. Mathematical Physics (5 Credits)

Course Outcomes (CO):

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

CO1: master the basic elements of complex mathematical analysis.

CO2: solve differential equations that are common in physical sciences.

CO3: apply group theory to solve mathematical problems of interest in Physics.

CO4: understanding how to use tensors in various physics problems.

Unit	Topics to be Covered	No. of Hours
I	Complex Analysis Complex Numbers and Variables, Complex Analyticity, Cauchy-Riemann Conditions, Classification of Singularities, Cauchy's Integral Theorem, Residues, Evaluation of Definite Integrals, Taylor and Laurent Expansions, Calculus of Residues, Evaluation of Definite Integrals, Jordan's Lemma.	20
II	Ordinary Differential Equations and Special Functions Linear ordinary differential equations and their singularities, Sturm-Liouville problem, expansion in orthogonal functions, Series solution of second order equations, Special Functions: Hermite and Laguerre Differential Equations, Hermite and Laguerre Polynomials.	20
III	Partial Differential Equations Laplace and Poisson Equation (With Particular Emphasis on Solving Boundary Value Problems in Electrostatics and Magnetostatics) ; Wave equation, Heat Equation, Green's Function Approach, Separation of Variables and Solution in Different Coordinates.	10

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IV	Group Theory Definition and Properties of Group, Discrete and Continuous groups, Subgroups and Cosets, Products of groups, Matrix Representation of a Group, (Ir)reducible Representations. Characters. Representations of Finite Groups. Examples of Continuous Groups, SO(3), SU(2) and SO(n) and SU(n), Generators of SU(2) and their Algebra, Representations of SU(2).	15
V	Elementary Tensor Analysis Coordinate Transformations, Contravariant and Covariant Vectors, Contravariant, Covariant and Mixed Tensors, Tensor Fields, Symmetric and Skew-symmetric Tensors, Fundamental Operations with Tensors, Metric Tensor, Conjugate Tensors and Associated Tensors.	10

References:

1. G. B. Arfken, *Mathematical Methods for Physicists*, Elsevier.
2. P. Dennery and A. Krzywicki, *Mathematics for Physicists*, Dover.
3. S. D. Joglekar, *Mathematical Physics: Basics (Vol. I) and Advanced (Vol. II)*, Universities Press.
4. A. W. Joshi, *Matrices and Tensors in Physics*, New Age Publishers.
5. R. V. Churchill and J.W. Brown, *Complex Variables and Applications*, McGrawHill.
6. P. M. Morse and H. Feshbach, *Methods of Theoretical Physics (Vol. I & II)*, Feshbach Publishing.
7. M. R. Spiegel, *Complex Variables*, McGrawHill.
8. W. K. Tung, *Group Theory in Physics*, World Scientific.
9. A. Das and S. Okubo, *Lie Groups and Lie Algebras for Physicists*, Hindustan Book Agency.
10. I. Gelfand and S. Fomin, *Calculus of Variations*, Dover.
11. W. Yourgrau and S. Mandelstam, *Variational Principles in Dynamics and Quantum Theory*, Dover.

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MPHY – CC102: Classical Mechanics (5 Credits)

Course Outcomes (CO):

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

CO1: know the difference between Newtonian mechanics and Analytic mechanics.

CO2: solve the mechanics problems using Lagrangian formalism, a different method from Newtonian mechanics.

CO3: understand the connection between classical mechanics and quantum mechanics from Hamiltonian formalism.

CO4: understand of basic concepts of special and general theory of relativity.

Unit	Topics to be Covered	No. of Hours
I	Lagrangian and Hamiltonian Dynamics Symmetry Properties of Space and Time and Conservations Laws, Lagrangian and Hamiltonian for Central Forces, Electromagnetic Forces, Coupled Oscillators and Other Simple Systems. Calculus of Variations and Euler - Lagrange's Equations of Motion, Modified Hamilton's Principle, Deductions of Hamilton's Equation and Lagrange's Equation from Variational Principle. Hamilton's Principle of Least Action.	20
II	Canonical transformations and Hamiltonian Jacobi Theory Generating Function, Canonical Transformation and its examples, Lagrange and Poisson Brackets and other Canonical Invariants, Equation of Motions, Jacobi Identity, Angular Momentum – Poisson Bracket Relations, The Hamilton – Jacobi Equation for Hamilton's Principal and Characteristic functions with example. The Harmonic Oscillator, Separation of Variable in Hamilton's – Jacobi equation, Action Angle Variables and its examples.	20
III	Central Force Motion Reduction of Two Body Central Force Problem to the Equivalent One Body Problem, General Properties of Central Force, Effective Potential, Motion in a Central Force Field – General Solution, Inverse Square Law Force, Kepler's Laws	10

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	– Laws of Gravitation From Kepler's Laws, Virial Theorem, Scattering in a Central Force Field.	
IV	Dynamics of Rigid Body Euler's Theorem and Its Applications, Finite and Infinitesimal Rotations, Rate of Change of a Vector, the Rigid Body Equation of Motion, Angular Momentum and Kinetic Energy of Motion About a Point, the Inertia Tensor and the Moment of Inertia, the Principal Axis Transformation, the Euler Equation of Motion. Rotating Frame, Coriolis Force, Foucault's Pendulum, Eulerian Coordinates and Equations of Motion for a Rigid Body, Motion of a Symmetrical Top.	15
V	Small Oscillations and Normal Modes (Coupled Oscillators) Potential Energy and Equilibrium, Stable, Unstable and Neutral Equilibrium, One – Dimensional Oscillator, Two Coupled Oscillators, Equation of Motion, Normal Coordinates and Normal Modes, Kinetic Energy and Potential Energy in Normal Coordinates, General Theory of Small Oscillations (n – Coupled Oscillators), Secular Equation and Eigen – Value Equation, Small Oscillations in Normal Coordinates with Examples.	10

References:

1. H. Goldstein, C. P. Poole and J.F. Safko, *Classical Mechanics*, Addison Wesley.
2. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata McGraw Hill.
3. J. V. Jose and E. J. Saletan, *Classical Dynamics: A Contemporary Approach*, Cambridge University Press.
4. L. D. Landau and E. M. Lifshitz, *Mechanics*, Butterworth Heinemann
5. I. C. Percival and D. Richards, *Introduction to Dynamics*, Cambridge University Press
6. R. D. Gregory, *Classical Mechanics*, Cambridge University Press
7. K. C. Gupta, *Classical Mechanics of Particles and Rigid Bodies*, John Wiley
8. J. W. Muller, *Classical Mechanics*, Kirsten World Scientific
9. T. W. B. Kibble and Frank H. Berkshire, *Classical Mechanics*, Imperial College Press
10. W. Dittrich and M. Reuter, *Advanced Classical and Quantum Dynamics*, Springer
11. V. I. Arnold, *Mathematical Methods of Classical Mechanics*, Springer

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MPHY – CC103: Electrodynamics and Plasma (5 Credits)

Course Outcomes (CO):

After completion of the course, the students will have understanding of:

CO1: Time-varying fields and Maxwell equations.

CO2: Various concepts of electromagnetic waves.

CO3: Radiation from localized time courses, and the charged particle dynamics.

Unit	Topic to be Covered	No. of Hours
I	Electromagnetic Wave Equation and Field Vectors Maxwell's Equation in Free Space, Plane Wave in Free Space. Dispersion of Electromagnetic Waves, Poynting Vector in Free Space, Polarization of Electromagnetic Waves, Electric Field Vector in terms of Scalar and Vector Potential, Wave Equation in terms of Scalar and Vector Potential.	15
II	Electromagnetic Wave and its Interaction with Matter on Macroscopic Scale Electromagnetic Wave (EMW) in Free Space Propagation of EMW – in isotropic, anisotropic dielectrics, in conducting media; Boundary conditions, reflection and refraction of EMW, Fresnel formulae, Brewster's law and degree of polarization total internal reflection and Critical Angle, Reflection from a Metallic Surface, Propagation of EMW between Conducting Planes.	15
III	Relativistic Electrodynamics Transformation Equation for Current Density and Charge Density, Vector Potential and Scalar Potentials, the Electromagnetic Field Tensor, Transformation Equation for Electric and Magnetic Field, Covariance of Maxwell Equation in four Tensor Form, Covariance of Maxwell and Transformation law of Lorentz force.	15
IV	Fields of Moving Charges Retarded and Advanced Potentials, Field due to an Oscillating Current Element and Oscillating Dipole, Lienard – Wiechert potentials, Field of Point Charge in	10

	Uniform Rectilinear Motion, Radiation from an Accelerated Charge Particle at Low and High Velocity.	
V	Plasma Physics Plasma : Definition and Characteristics, Saha's Theory of Thermal Ionization, Debye's Length, Debye's Screened Potential, Plasma Oscillation, Magneto Hydrodynamic (MHD) Equation, Kinetic Theory of Plasma, Landau's Damping, Plasma Confinement, Pinch Effect, Wave Propagation Parallel and Perpendicular to Magnetic Field, Alfven Waves.	20

References:

1. John David Jackson, *Classical Electrodynamics*, 3rd Edition, Wiley
2. David Griffiths *Introduction to Electrodynamics*, 3rd Edition, Benjamin Cummings
3. J. Schwinger, L.L. Deraad Jr., K. A. Milton, W-Y. Tsai and J. Norton, *Principles of Electrodynamics*, Westview Press
4. Charles A Brau, *Modern Problems in Classical Electrodynamics* Oxford Univ. Press.
5. H.J.W. Mueller-Kirsten, *Electrodynamics: An introduction including quantum Effects*, World Scientific.
6. L.D. Landau and E.M. Lifshitz and L.P. Pitaevskii, *Electrodynamics of Continuous Media*, Oxford.

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PHY – CC104: Physics Laboratory – I (5 credits)

Course Outcomes (CO):

At the end of the course:

CO1: The student should have knowledge of the different experimental techniques.

CO2: The student should have understood the basics of physics involved in experiments.

CO3: The student should be able to apply the concepts of physics and do the interpretation and acquire the result.

Exp. No.	Name of the Experiment
1	Hall Effect
2	Four Probe Method
3	Work function of Tungsten
4	Measurement of Laser parameters Using He-Ne laser
5	Refractive index of Liquids using He-Ne laser
6	Thermal Conductivity of Teflon
7	Susceptibility of Gadolinium
8	Transmission Line, Propagation of Mechanical and EM waves
9	Measurement of e/m using Thomson Method
10	Measurement of Planck's Constant using Photoelectric Effect
11	Determination of wavelength of a laser by Michelson Interferometer
12	Millikan Oil Drop Experiment
13	Frank Hertz Experiment
14	Experiment using Semiconductor Laser
15	Band-Gap
16	Study of Frequency Modulation
17	Zeeman Effect
18	Compact Microwave training System Experiment
19	Raman Spectra
20	Hydrogen Spectrum and Solar Spectrum-Rydberg's Constant
21	Measurement of Stefan's Constant
22	Study of Characteristics of UJT
23	Velocity of sound in Air by CRO Method
24	Determination of Numerical Aperture of an Optical Fiber
25	Direct Reading of (e/m of an Electron) with a Laser Source.

Note: 1. As per the requirement of the syllabus additional experiments may be included.

2. At least 10 experiments to be done in the Lab session.

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Ability Enhancement Compulsory Course (5 Credits Each)

MAECC101: Environmental Sustainability & Swachha Bharat Abhiyan Activities

Course Outcomes (CO):

After completion of the course, the student will

CO1: understand the concept of environmental Sustainability.

CO2: understand the concept and types of natural resources and environmental pollution.

CO3: evaluate the anomalies created due to haphazard population growth and its impact on biodiversity and population.

CO4: understand the concept of Swachha Bharat Abhiyan and importance of cleanliness.

Unit	Topics to be Covered	No. of Hours
I	Environmental Ethics and Ecosystem Concept of sustainable development with reference to human values in western and Indian perspective, sustainable development & conservation of natural resources (Nature, factors, structure, development and people participation) development, environment- rural and urban, concept of Ecosystem.	15
II	Development and its Effect on Environment Environment pollution- water, air, noise etc. due to Urbanization, Industrial civilization, Concept of Global Warming, Climate change, Green House Effect, Acid rain, Ozone layer depletion, Menace of encroachment to impact on habit & habitat on indigenous flora & fauna.	15
III	Concept of Biodiversity and its Conservation Environment; degradation and conservation Govt. Policies, Social effects and role of social reforms in this direction. Role of scientific conservation of	15

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	environmental concept of three 'R' (reduce, reuse, recycle). Need of environmental education and awareness programme and ecological economics.	
IV	Swachha Bharat Abhiyan The Concept of Swachhata as Personal, Gandhian Approach towards social and environmental Moral Values & concept of Swachhata and its relation to moral Upgradation of society and freedom struggle, Awareness Programme related to Swachhata. Role of 'Swachchagrahis' in Swachha Bharat Abhiyan. Sanitation and Hygiene, why sanitation is needed, sanitation and human rights, plantation, values of nature, concept of community participation and role of state agencies. Case study of Sanitation, effects of cleanliness, diseases- infectious and vector- born ideas of spread of diseases through body and other biological fluids and excreta.	20
V	Assignment/ Practical/ Field Work based on Unit – IV	10

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Physics (M.Sc.) Details of CBCS Syllabus

SEMESTER – II

Core Courses (5 Credit Each)

MPHY – CC205: Numerical Analysis and Simulation (5 credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: Learn how to interpret and analyze data visually, both during and after computation.

CO2: Gain an ability to apply physical principles to real-world problems.

CO3: Acquire a working knowledge of basic research methodologies, data analysis and interpretation.

CO4: Understand various simulation techniques which can be used in future by students to analyze the data.

Unit	Topics to be covered	No. of Hours
I	i. Solution of Algebraic and Transcendental Equations Solution of the equations graphically, Newton –Raphson method or Successive substitution method, Rule of False Position (Regula False), Iteration method, Bisection method.	20
	ii. Solution of Linear Systems Iterative methods or indirect methods, Jacobi's method, Solution of simultaneous linear equations: Matrix inversion method.	
II	Numerical Interpolations and Extrapolations Newton's forward interpolation formula, Newton's backward interpolation formulas, Central difference interpolation, Lagrange's interpolation formula, Extrapolation.	15

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III	<p>i. Numerical differentiation</p> <p>Differentiation using Newton's forward difference, Differentiation using Newton's backward difference, Differentiation using Stirling's formula.</p> <p>ii. Numerical Integration</p> <p>Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule, Gaussian quadrature rule.</p>	20
IV	<p>Numerical solution of ordinary differential equations</p> <p>Taylor's method, Euler's method, Runge-Kutta methods, Picard method. Numerical solution of higher order differential equations.</p>	10
V	<p>Simulation Techniques</p> <p>Generation of uniformly distributed random integers, Statistical tests of randomness, Monte Carlo methods, molecular dynamics, Simulation methods for the Ising Model and Atomic Fluids.</p>	10

References:

1. Gerald, *Applied Numerical Analysis*, Pearson.
2. Landau and Binder, *A Guide to Monte Carlo Simulations in Statistical Physics*, Cambridge University Press.
3. Teukolsky, Vetterling and Flannery, *Numerical Recipes*, Cambridge University Press
4. W. H. Press, B.P. Flannery, S.A. Teukolsky and W.T. Vetterling, *Numerical Recipes: The Art of Scientific Computing*, Cambridge University Press
5. H. M. Antia, *Numerical Methods for Scientists and Engineers*, Hindustan Book Agency
6. D. W. Heermann, *Computer Simulation Methods in Theoretical Physics*, Springer
7. H. Gould and J. Tobochnik, *An Introduction to Computer Simulation Methods*, AddisonWesley
8. J. M. Thijssen, *Computational Physics*, Cambridge University Press.

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MPHY – CC206: Quantum Mechanics (5 Credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: Have a working knowledge of the foundations, techniques and key results of quantum mechanics.

CO2: to comprehend basic quantum mechanical applications at the research level.

CO3: gain an ability to competently explain/teach quantum physics to others.

Unit	Topics to be covered	No. of Hours
I	Basics of Quantum Mechanics Origin of Quantum Mechanics, Particle Aspects of Radiation, wave aspect of radiation, particle versus waves, intermediate nature of microphysical world, quantization rules and wave packets.	12
II	Linear Vector and Representation Theory Linear Vector Space, Basis, Eigenvalue equations, Orthogonality and completeness conditions, Properties of Hermitian operators, Dirac's Bra-Ket notation, Matrix representation of Observables and states, Determination of eigenvalues and eigenstate for observables using matrix representations, Change of representation and unitary transformations, Coordinate and momentum representations, Transformation between coordinate and momentum representations.	20
III	Quantum Dynamics Schrodinger, Heisenberg and Interaction pictures. Linear Harmonic Oscillator solution using Schrodinger picture and Heisenberg picture. Theory of Angular Momentum: Symmetry, invariance and conservation laws, relation between rotation and angular momentum, commutation rules, Matrix representations, addition of angular momenta and Clebsch-Gordon coefficients, Pauli spin matrices.	18

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IV	Approximation Methods Time-independent Perturbation theory for discrete levels- non-degenerate and degenerate cases and applications to fine structure splitting, Zeeman effect (Normal and anomalous), Stark effect, and other simple cases, Variational method and applications to helium atom and simple cases; WKB approximation and applications to simple cases. Time dependent Perturbation theory, Fermi's Golden rule, Semi-classical theory of interaction of atoms with radiation.	15
V	Scattering Theory Differential and Total Scattering Cross-Sections Laws, Partial Wave Analysis and Application to Simple Cases; Integral form of Scattering Equation, Formal Expression for Scattering Amplitude – Green's Function, Born Approximation Validity and Simple Applications.	10

References:

1. C. Cohen Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Vol. I)*, Wiley
2. L.I. Schiff, *Quantum Mechanics*, McGraw Hill
3. R. Shankar, *Principles of Quantum Mechanics*, Springer
4. E. Merzbacher, *Quantum Mechanics*, John Wiley and Sons
5. Messiah, *Quantum Mechanics (Vol. I)*, Dover
6. Das, *Lectures on Quantum Mechanics*, Hindustan Book Agency
7. R.P. Feynman, *Feynman Lectures on Physics (Vol. III)*, Addison Wesley
8. A. Levi, *Applied Quantum Mechanics*, Cambridge Univ Press

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MPHY – CC207: Electronics (5 Credits)

Course Outcomes (CO):

Students will have understanding of

CO1: Fundamental designing concepts of different types of logic gates, minimization techniques etc.

CO2: Designing of different types of the Digital circuits, and to give the computational details for Digital circuits.

CO3: Characteristics of devices like PNP, and NPN junction diode and truth tables of different gates.

CO4: Basic elements and to measure their values with multimeter and their characteristic study.

CO5: How to construct electronic circuit.

Unit	Topics to be covered	No. of Hours
I	Semiconductor Devices BJT, JFET and MOSFET: Construction and Characteristics, Principle of JFET and MOSFET operation, UJT, SCR, Zener diode: Structure and Working.	15
II	Feedback Amplifiers and Oscillator BJT biasing: Bias stability, Stability factor of fixed bias circuit, voltage divider bias, Emitter follower, Equivalent circuit of the BJT Amplifier, Two port device and Hybrid Model. Negative feedback and its properties: Feedback Connection, Gain with feedback, Advantage of Negative Feedback, Input - Output impedance with feedback. Oscillator: Principles, Barkhausen criterion, Phase Shift Oscillator, Wien - Bridge oscillator.	20

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III	Operational Amplifier Circuit Symbol, the Ideal Operational Amplifier, Ideal Op-Amp Inverting amplifier, Non-Inverting Amplifier using ideal Op-Amp, Adder, Subtractor, Differentiator, Integrator.	15
IV	Digital Electronics Digital signal, Number systems, Binary number system, Octal Number system, Hexadecimal number system, Binary arithmetic, Logic Gates : AND, OR, NAND, NOR, NOT, XOR, Boolean algebra theorems, De-Morgans theorem, Karnaugh Map. Half adder, Full adder, Flip-Flop: RS, JK, Elementary idea of Registers, Counters.	15
V	Microprocessor Microcomputer Block Diagram, System Buses, 8085 Microprocessor, Architecture and Operation.	10

References:

1. P. Horowitz and W. Hill, *The Art of Electronics*, Cambridge University Press.
2. J. Millman and A. Grabel, *Microelectronics*, McGraw Hill.
3. J. J. Cathey, *Schaum's Outline of Electronic Devices and Circuits*, McGraw Hill.
4. M. Forrest, *Electronic Sensor Circuits and Projects*, Master Publishing Inc.
5. W. Kleitz, *Digital Electronics: A Practical Approach*, Prentice Hall.
6. J. H. Moore, C. C. Davis and M. A. Coplan, *Building Scientific Apparatus*, Cambridge University Press.

MPHY – CC208: Atomic, Molecular Spectroscopy and Laser (5 credits)

Course Outcomes (CO):

Students will have understanding of

CO1: Atomic spectroscopy of one and two valence electron atoms.

CO2: The change in behavior of atoms in external applied electric and magnetic field.

CO3: Rotational, vibrational, electronic and Raman spectra of molecules.

CO4: Electron spin and nuclear magnetic resonance spectroscopy.

CO5: Principle, working and applications of Laser.

Unit	Topics to be Covered	No. of Hours
I	Atomic Spectra – I i. Quantum numbers, Electron spin, Space quantization, Vector atom model, Magnetic dipole moment ii. Spin-Orbit coupling, <i>LS</i> and <i>jj</i> Coupling Scheme iii. Spectra of Alkali Elements iv. Spectra of Alkaline Earth Elements	10
II	Atomic Spectra – II i. Normal and Anomalous Zeeman Effect. ii. Paschen – Back Effect iii. Stark Effect iv. Hyperfine Structure v. Breadth of Spectral Lines, Natural and Doppler Broadening vi. Continuous and Characteristic X-ray spectra, Moseley's Law, Augur effect	20

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MPHY – CC209: Physics Laboratory – II (Programming: Numerical Methods using C/C++/MATLAB/Python Software) (5 Credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: Understand the basic idea about finding solutions using computational methods basics.

CO2: Learn how to interpret and analyze data visually, both during and after computation.

CO3: Gain an ability to apply physical principles to real-world problems.

CO4: Acquire a working knowledge of basic research methodologies, data analysis and interpretation.

CO5: Realize the impact of physics in the global/societal context.

Exp. No.	Name of the Experiment
1	To find mean, standard deviation and frequency deviation of an actual data set from any physics experiment.
2	Plotting of graphs of functions such as exponential and trigonometric functions.
3	Successive approximation (Method of Iteration), Newton - Raphson method
4	Matrix inversion, Lagrange's Interpolation formula.
5	Euler's method, Runge-Kutta method (Fourth order).
6	To find the area of a unit circle by Monte Carlo integration.
7	Solution of second order solution family of differential equation.
8	Plotting of third order solution family of differential equation.
9	To simulate the random walk.
10	Trapezoidal rule
11	Simpson's $1/3^{\text{rd}}$ rule
12	Simpson's $3/8^{\text{rd}}$ rule
13	Gauss Elimination method
14	The Bisection method
15	Predictor Corrector method

Note: 1. As per the requirement of the syllabus additional experiments may be included.

2. At least 10 experiments to be done in the Lab session.

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Skill Enhancement Course (5 Credits Each)

Basket: Skill Enhancement Courses (SEC)

A student can choose one from these. For example:

1. Physics and Workshop Training
2. Web designing
3. Cookery and Bakery
4. Solid Waste Management
5. Environmental Law
6. Life-Skill and Skill Management

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MPHY – SEC201: Physics and Workshop Training (5 Credits)

Course Outcomes (CO):

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

CO1: solve the problem and also think methodically, independently and draw a logical conclusion.

CO2: use modern techniques, decent equipments and scientific softwares. Develop the following experimental tools: Numerically model simple physical systems using Euler's method, curve fitting, and error analysis.

CO3: describe the methodology of science and the relationship between observation and theory & learn to minimize contributing variables and recognize the limitations of equipment.

CO4: develop the proficiency in the acquisition of data using a variety of laboratory instruments and in the analysis and interpretation of such data.

Unit	Topics to be covered	No. of Hours
I	Introduction Measuring Units. Conversion to SI and CGS, Familiarization with Meter Scale, Vernier Calliper, Screw Gauge and Their Utility, Measure the Dimension of a Solid Block, Volume of Cylindrical Beaker/Glass, Diameter of a Thin Wire, Thickness of Metal Sheet, etc.	15
II	Electrical and Electronic Skill Use of Multimeter, Soldering of Electrical Circuits having Discrete Components (R, L, C, diode) and ICs on PCB, Operation of Oscilloscope, Making Regulated Power Supply.	15

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III	Basic Electricity Principles Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations.	15
IV	Generators and Transformers DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.	15
V	Fundamentals of IC Operational amplifier 7400, 741 IC, simple circuits designing using opamps, Integrator, Differentiator, Comparator, Adder, Subtractor.	15

References:

1. B. L. Theraja, *A text book in Electrical Technology*, S. Chand and Company.
2. M.G. Say, *Performance and design of AC Machines*, CBS.
3. K.C. John, *Mechanical Workshop Practice*, PHI Learning Pvt. Ltd.
4. Bruce J. Black, *Workshop Processes: Practices and Materials*, Routledge.
5. Lawrence Smyth/Liam Hennessy, *New Engineering Technology*, Educational Company of Ireland.

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Physics (M.Sc.) Details of CBCS Syllabus

SEMESTER – III

Core Courses (5 Credit Each)

MPHY – CC310: Statistical Mechanics (5 Credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: understand basic knowledge of thermodynamic systems.

CO2: understand the basic idea about statistical distributions.

CO3: Impart the knowledge about the phase transitions and potentials.

CO4: Understand the applications of statistical laws.

Unit	Topics to be Covered	No. of Hours
I	The Statistical Basis of Thermodynamics Postulates of classical statistical mechanics, macroscopic and microscopic states, Phase space, Ensemble – Microcanonical, canonical and grand canonical, Statistical equilibrium, density distribution of phase point, Liouville's theorem.	20
II	Ideal Classical Gas Partition function of a classical ideal gas, thermodynamical potentials in terms of partition function for an ideal monoatomic gas in microcanonical and grand canonical ensembles, entropy of mixing and Gibbs paradox, Maxwell-Boltzmann distribution law, entropy of monoatomic gas.	20
III	Quantum Statistics and Applications – I Density matrix, quantum ensembles, ideal Bose gas, Bose condensation, liquid He II, superfluidity and Landau's theory.	10

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IV	Quantum Statistics and Applications – II Ideal Fermi gas, specific heat and Pauli Paramagnetism, Principle of detailed balance, Landau diamagnetism, white dwarfs and Chandrasekhar limit, Ising model, Random walk and Brownian motions.	15
V	Nonequilibrium Processes Features of Equilibrium and Non equilibrium Thermodynamics, Linear theory of Non equilibrium Thermodynamics, Current and Affinity, Onsager relation, Fluctuations, Microsystems.	10

References:

1. Introduction to Thermodynamics, Classical and Statistical, Richard E. Sonntag (Univ. of Michigan), Gordan J. Van Wylen (Hope College), 3rd Edition.
2. Statistical Mechanics, R.K. Pathria, 2nd Edition, Elsevier, 1996.
3. Thermodynamics and Statistical Mechanics, John M. Seddon and Julian d. gale, 3rd Edition, RSC Publication, 2001, UK.

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MPHY – CC311: Condensed Matter Physics (5 Credits)

Course Outcomes (CO):

Students will have understanding of

CO1: Structure in solids and their determination using XRD.

CO2: Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.

CO3: Electrical, Thermal, Magnetic and Dielectric properties of Solids.

Unit	Topics to be Covered	No. of Hours
I	Crystal structure Reciprocal lattice and applications, Brillouin Zones, Laue equations and Bragg's law, Laue and powder diffraction, Structure factor, atomic form factor, Intensity of diffraction maxima, Extinctions due to Lattice centering.	20
II	Electronic Properties Motion of electron in periodic lattice, Bloch theorem, nearly free electron model, tight binding and cellular methods, effective mass, intrinsic and extrinsic semiconductors, Fermi surface, Cyclotron resonance and de Hass-van Alphen effect.	15
III	Magnetic Properties Heisenberg model, molecular field theory, Spin waves and magnons, Curie-Weiss law for susceptibility, Theories of ferromagnetism, anti-ferromagnetism and ferrimagnetism.	10
IV	Superconductivity Meissner effect, Critical Field, London equations, Penetration Depth, Flux quantization, BCS Theory, Band gap in Superconductor, DC and AC Josephson effect, High T _c Superconductors.	15

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V	Dielectric Properties Microscopic concept of dielectric polarization, Langevin theory of polarization, Clausius-Mossotti equation, Dielectrics in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectricity, optical properties of crystals.	15
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References:

1. Introduction to Solid State Physics, 3rd and 6th Editions, C. Kittel, Wiley Publishing
2. Condensed Matter in a Nutshell, Wil G.D. Mahan, Princeton Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin, Holt-Rinehart-Winston, 1976.
4. Elementary Solid State Physics, Principles and Applications, Ali Omer, M Addison Wesley Publication, 2011.

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MPHY – CC312: Nuclear and Particle Physics (5 Credits)

Course Outcomes (CO):

At the end of the course, the students will be able to

CO1: Acquire basic knowledge about nuclear and particle physics.

CO2: Develop the nuclear reactions and neutron physics.

CO3: Understand the nuclear fission and fusion reactions.

CO4: Impart the knowledge about the nuclear forces and elementary particles.

Unit	Topics to be Covered	No. of Hours
I	Nuclear Forces: Exchange forces and tensor forces, Low energy nucleon-nucleon scattering, Effective range theory, Deuteron problem, High energy nucleon-nucleon scattering (Quantitative Discussion), Charge independence, spin dependence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interactions.	20
II	Nuclear reactions: Kinematics and conservation laws, Nuclear Reactions and Cross sections, Theory of Compound nucleus, Breit-Wigner single level formula, Mechanism of nuclear fission and fusion, nuclear reactors.	15
III	Nuclear Models: (a) Single particle shell model: magic numbers, spin, parity, magnetic dipole moment, electric dipole moment (b) The Nilsson unified model, (c) Collective model: vibrational and rotation states, β and γ bands.	10
IV	Nuclear decay: (a) Fermi theory of β decay, allowed and forbidden transitions, Parity violation in β decay and Helicity of neutrino, (b) Radiative transitions in nuclei (γ -decay), Spontaneous decay, internal conversion, Moddbaur effect.	15
V	Elementary Particle Physics: Conservations Laws and Symmetry, Strangeness, hypercharge, CPT invariance, Classification of elementary particles, SU(2)	15

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	symmetry and its application to decay and scattering processes, SU(3) symmetry and the Quark model, Elementary idea of chromodynamics.	
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References:

1. Kenneth S. Krane, Introductory Nuclear Physics, Wiley India, new Delhi (2008).
2. J. Basdevant, J. Rich, M. Spiro, Fundamentals in Nuclear Physics, Springer, New York (2005).
3. D. Griffiths, Introduction to Elementary Particles, Wiley VCH, Weinheim (2008).
4. D.C. Tayal, nuclear Physics, 4th Edition, Himalaya Publishing House, Bombay (1980).

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MPHY – CC313: Biophysics (5 Credits)

Course Outcomes (CO):

At the end of the course, students will be able to

CO1: understand basic knowledge of Biomolecular chemistry and functions.

CO2: understand the basic idea about the Structure and Function of Nucleic Acids.

CO4: impart the knowledge about the Function of Carbohydrates and Proteins.

CO5: understand the applications of Biomolecules.

Unit	Topics to be Covered	No. of Hours
I	Building Blocks & Structure of Living State: Atoms and ions, molecules essential for life, what is life. Living state interactions: Forces and molecular bonds, electric and thermal interactions, electric dipoles, Casimir interactions, domains of physics in biology.	15
II	Heat Transfer in biomaterials: Heat Transfer Mechanism, The Heat Equation, Joule heating of tissue, Living State Thermodynamics: Thermodynamics equilibrium, first law of thermodynamics and conservation of energy, Entropy and second law of thermodynamics, Casimir contribution of free energy, Protein folding and unfolding.	15
III	Open systems and chemical thermodynamics: Enthalpy, Gibbs Free energy and chemical potential, activation energy and rate constants, enzymatic reactions, ATP hydrolysis and synthesis, Entropy of mixing, The Grand Canonical ensemble, Hemoglobin.	15
IV	Diffusion and Transport: Maxwell-Boltzmann statistics, Fick's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field. Lateral diffusion in membranes, Navier stokes equation, low Reynold's number Transport, active and passive transport.	15
V	Bioenergetics and Molecular motors: Kinesins, Dyneins, and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorptions in biomolecules vibrational spectra of bio-biomolecules.	15

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References:

1. Principles of Biochemistry by A.L. Lehninger, D.L. Nelson and M.M. Cox, CBS Publishers, New Delhi, 1993.
2. Biochemistry by L. Stryer, W.H. Freeman and Co., Newyork, 1997.
3. Biophysics by Vasantha Pattabhi and N. Gautham, Narosa Publishing House, New Delhi, 2002.
4. Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartlett Publishers.
5. Aspects of Biophysics, Hughe S W, John Willey and Sons.
6. Essentials of Biophysics by P Narayanan, New Age International.

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MPHY – CC314: Physics Laboratory – III (5 Credits)

Course Outcomes (CO):

At the end of the course,

CO1: The student will have a knowledge on the different experimental techniques involved in electronics.

CO2: The student should be able to independently construct the circuits.

CO3: The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

Exp. No.	Name of the Experiment
1.	Study of Transistor Bias Stability
2.	Construction of a single stage RC Coupled amplifier using transistor and study of its frequency response.
3.	Construction of a two stage RC Coupled amplifier using transistor and study of its frequency response.
4.	Study of Silicon Controlled Rectifier.
5.	Study the characteristics of UJT.
6.	Experiment on FET and MOSFET characterization and application as an amplifier.
7.	Construction of an Astable multivibrator circuit using OP AMP and 555 IC's.
8.	Characteristics of Tunnel diode and Gunn diode.
9.	Construction of a bistable multivibrator circuit using IC555 and study its performance.
10.	Construction of adder, subtractor, differentiator and integrator circuits using the given OP-Amp.
11.	Construction of and A/D converter circuit and study its performance.
12.	Construction of an D/A converter circuit and study its performance.
13.	Construction of half-adder and full-adder circuit using NAND gates and study their performance.

14.	Construction of half-subtractor and full-subtractor circuit using NAND gates.
15.	Design of schmitt's trigger using ICs 741 and 555 timer – Study of frequency divides.
16.	Flip-flops – RS, JK and D Flip flops.
17.	Shift register and Photo diode characteristics.
18.	Study of counters : Ripple, Mod 3 and Mod 5 Counters.
19.	Photo-diode characteristics.
20.	Photo-transistor characteristics.
21.	Analog computer circuits design – solving the simultaneous equarions.
22.	Multiplexer and Demultiplexer.
23.	Decoders and Encoders.

Note: 1. As per the requirement of the syllabus additional experiments may be included.

2. At least 10 experiments to be done in the Lab session.

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Physics (M.Sc.) Details of CBCS Syllabus

SEMESTER – IV

Discipline Specific Elective Courses (5 Credit Each)

MPHY-DSE-401: A. Plasma Physics (5 Credits)

Course Outcomes (CO):

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

CO1: Understand the introduction to the field of Biophysics.

CO2: Comprehend the study of heat transfer in biomaterials.

CO3: Develop knowledge on study of chemical thermodynamics.

CO4: Visualize the important connection between theory and experiment.

Unit	Topic to be Covered	No. of Hours
I	Basic (Single Particle Approach) Charged particles in uniform and non-uniform electromagnetic field, Plasma – the fourth state of matter, Concept of electron and ion temperature, Debye length, Cyclotron Frequency, Larmor Radius, Drift Velocity of guiding center, Magnetic moment mirror systems and their relation to the plasma confinement, Adiabatic invariants.	15
II	Magneto Hydro Dynamics (Fluid Approach) Introduction to ideal MHD systems, Fundamental equations of magneto hydrodynamic systems, Diffusion and mobility of charged particles in plasma, Plasma as fluid and MHD equations, Approximations and linearization of MHD from dimensional considerations, single fluid MHD equation, MHD Generator.	15

III	Waves and instabilities in Plasma Waves in unmagnetized plasma, Energy transport, Ion acoustics waves and MHD waves, Issue of plasma stability and the use of normal mode to analyze stability, Interaction between plasma particles, Perturbation at two fluid interface, Rayleigh instability, Kelvin Helmholtz instability and Jeans instability.	15
IV	Kinetic Theory Need for kinetic theory and MHD as approximation of kinetic theory, Meaning of $f(v)$, Phase space for many particle motion, Velocity and space distribution function, Derivation of fluid equation and Electron-ion plasma oscillation frequency, Derivation of Landau damping, Equations of Kinetic theory and Vlasov equations for fluid dynamics.	20
V	Applications Saha's theory of thermal ionization, Application in Space Science, Controlled Thermonuclear Fusion, Magnetic reconnection, Dynamo action.	10

References:

1. A.R. Choudhari, "The Physics of fluid and plasmas" (Cambridge UP, 1998)
2. Chen Francis, "Plasma Physics", II Edition (Plenum Press, 1984)
3. Bitten Court J.A., "Fundamentals of Plasma Physics" (Pergamon Press, 1988)
4. Paul Bellan, "Fundamentals of Plasma Physics", (CUP, 2006).

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MPHY-DSE-401: B. Nano Science (5 Credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: understand the basic knowledge on nanoscience and nanotechnology.

CO2: understand the basic idea about the nanostructure.

CO3: Impart the knowledge about the properties and characteristics techniques of nanomaterials.

CO4: Understand the applications of nanomaterials.

Unit	Topic to be Covered	No. of Hours
I	Introduction and Basic Principles Definition of Nanomaterials, Properties, Applications and Scope of Nano-science, Quantum Size effect, Electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of quantum well structure, Quantum wells, Quantum wires and Quantum Dots: Preparation and properties, Conduction electrons and dimensionality, Properties dependent on density of states, Carbon nanostructures: Fullerenes, structure, Superconductivity in C60, Carbon nanotubes: synthesis and structure, Electrical and mechanical properties.	20
II	Synthesis of Materials Techniques for synthesis: Top-down approach: Ball milling, Bottom-up approach: Chemical methods of synthesis, RF Plasma and Pulsed Laser techniques, Biological methods: synthesis using microorganisms, and plant extracts.	15
III	Characterization Techniques UV-Vis spectroscopy, Infrared spectroscopy, X-ray Fluorescence, Atomic absorption spectroscopy, Raman spectroscopy, NMR, Mass spectroscopy, Circular	15

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	dichroism spectroscopy, X-ray Diffraction technique, TEM and SEM, FTIR, DTA and DSC.	
IV	Magnetic Nanoparticles Magnetic nanoparticle, multiferroic and smart materials, Elementary idea of NEMS and nanotransistors.	10
V	Dielectric and Multiferroic Materials Theory of Dielectrics, Piezoelectricity, Ferroelectricity, Anti-Ferroelectricity and their applications, Nano-structured Ferroelectric materials, Synthesis and Characterization, Techniques of Ferroelectric nano-materials, multiferroic and smart materials.	15

References:

1. Nanostructure and Nanomaterials, Synthesis, properties and application, 2nd Edition by Guozhong Cao & Yingwang published by Word Scientific Published, Printed in 2004, Singapore.
2. Handbook of Nanotechnology, 3rd Edition by Bhushan published in Springer, Printed 2004, Germany.
3. Nanostructure Materials, processing, properties and potential applications, 2nd Edition by Carl C Koch published by William Andrew publications, Printed in 2007, USA.
4. Nanomaterials, synthesis, properties and applications, 2nd Edition by A.S. Edelstein published by Institute of Physics Publishing Bristol and Philadelphia, Printed in 2000, UK.

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MPHY-DSE-401: C. Laser and Photonics (5 Credits)

Course Outcomes (CO):

At the end of this course, the student will be able to

CO1: understand the theory behind laser and learn about the different types of Lasers.

CO2: Knowledge of fundamental physics of photonics is developed to a high level.

CO3: The course prepares students to be able to use sophisticated instrumental intelligently, with a good understanding of its capabilities and limitations.

Unit	Topics to be Covered	No. of Hours
I	Basic Principles Laser rate equation for three level and four level systems, Dynamics of Laser Process: Switching, Mode locking, mode pulling, lamb dip, hole burning, Energy levels and radiating properties of molecules, liquids and solids, Laser amplifier, Laser resonators, Techniques of laser excitation.	20
II	Non-linear optical effects Harmonic generation, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, parametric generation, Self-focusing of light, Two phonon absorption, Doppler free two photon spectroscopy, Laser spectroscopy.	20
III	Applications of Laser Fabrication of electronic components, Material processing, Laser Communication, Holography, Military applications, Medical applications, Star Wars, Laser hazards and Laser safety, Optical amplifiers, Infrared optical devices. Laser cooling, Trapping.	10

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IV	Optical Fiber Communication Optical Fiber structure, Wave guiding and Fabrication of Fiber, Types of Fiber and Solution of Maxwell's equation inside Fiber, Signal degradation and attenuation in Optical Fibers.	15
V	Optical Fiber Systems Optical sources (ILD and PIN Diode) and Optical Detectors (APD), Analog and Digital optical fiber Transmission System (PDH, SDH and WDM Technology).	10

References:

1. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley, New York, 1991.
2. B. P. Pal (Ed.), "Guided Wave Optical Components and Devices", Academic Press, 2006.
3. F. G. Smith and T. A. King, "Optics and Photonics", John Wiley, Chichester, 2000.
4. K. Thyagarajan and A. Ghatak, "Nonlinear Optics, in Encyclopedia of Modern Optics (Editors: Bob Guenther et. al.)", Elsevier Ltd. 2005.

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MPHY-DSE-401: D. Crystal Physics and X-ray Crystallography (5 Credits)

Course Outcomes (CO):

At the end of this course, structure will be able to

CO1: know the structure of various crystals.

CO2: know the theoretical framework like symmetry and space groups.

CO3: know to characterize the crystal using X – Ray diffraction experiments and

CO4: also would be able to analyze the collected experimental data.

Unit	Topics to be Covered	No. of Hours
I	Geometry of Crystals Introduction, crystal systems, symmetry, primitive and non-primitive cells, lattice directions and planes, unit cells of hcp and ccp structures, constructing crystals, some simple ionic and covalent structures.	20
II	Crystal Symmetry Bravais lattices, space groups and crystal structures, Symmetry of the fourteen Bravais lattices, coordination of Bravais lattice points, space filling polyhedral, thirty-two crystal classes, centers and inversion axes of symmetry, Crystal symmetry and properties, translation symmetry elements, Quasiperiodic crystals or crystalloids.	20
III	Lattice Representations Indexing lattice directions, lattice planes, miller indices, zones, zone axes, zone law, transforming miller indices and zone axes symbols, reciprocal lattice vectors, reciprocal lattice, unit cells, for cubic crystals, proofs of some geometric relationships using reciprocal lattice vectors, Addition rule, Weiss zone law, d spacing of lattice points.	10

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IV	X-Ray Diffraction Diffraction, Bragg's law, Diffraction methods, scattering by electrons, atoms, unit cell, Introduction to X-rays, electromagnetic radiation, continuous spectrum, characteristic spectrum, absorption, filters, production of X-rays, detection of X-rays, safety precautions, Contributions of Laue, Bragg and Ewald to X-ray diffraction, Indexing of X-ray diffraction pattern.	15
V	Crystal Defect Representing crystals in projection, Crystal planes, stacking faults and twins, stereographic projection, Point defects, line defect, planar faults, role of dislocations in Plastic deformation and crystal growth, color centers.	10

References:

1. C. Hammond, The basics of Crystallography and Diffraction, Oxford University Press, New York (2009).
2. B.D. Cullity, Elements of X-ray Diffraction, Addison Wesley, Massachusetts (1956).
3. C. Suryanarayana, M.G. Norton, X-ray Diffraction – A practical approach, Plenum press, New York (1998).
4. C. Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India, New Delhi (2004).

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MPHY-DSE-401: E. Environmental Physics (5 Credits)

Course Outcomes (CO):

At the end of this course, students will be able to

CO1: understand the importance of basics of environmental processes.

CO2: get opportunities of working metrological stations and even establish metrological stations in remote places for better future.

CO3: develop his/her understanding of global and regional climate change.

Unit	Topics to be Covered	No. of Hours
I	Essentials of Environmental Physics Structure and thermodynamics of the atmosphere, Composition of air, Greenhouse effect, Transport of matter, energy and momentum in nature, Stratification and stability of atmosphere, Laws of motion, hydrostatic equilibrium, General circulation of the tropics, Elements of weather and climate of India.	20
II	Solar and terrestrial Radiation Physics of radiation, Interaction of light with matter, Rayleigh and Mie scattering, Laws of radiation (Kirchhoff's law, Planck's law, Beer's law, Wien's displacement law, etc.) Solar and terrestrial spectra, UV radiation, Ozone depletion problems, IR absorption energy balance of earth atmosphere system.	15
III	Environmental Pollution and Degradation Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors governing air, water and noise pollution, Air and water quality standards, Waste disposal, Heat island effect, Land and sea breeze, Puffs and plumes, Gaseous and particulate matters, Wet and dry deposition.	15

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IV	Environmental Changes and Remote Sensing Energy sources and combustion processes, Renewable sources of energy, Solar energy, Wind energy, bioenergy, Hydropower, Fuel cells, nuclear energy, Forestry and bioenergy.	10
V	Global and Regional Climate Elements of weather and climate, Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, Viscous forces, Inertia forces, Reynolds number, Enhanced Greenhouse effect. Energy balance – a zero-dimensional Greenhouse model.	15

References:

1. Egbert Boeker and Rienk Van Groundelle, Environmental Physics, John Wiley.
2. J. T. Houghton, The Physics of atmosphere, Cambridge University Press, 1977.
3. J. Twidell and J. Weir, Renewable Energy Resources, Elbs, 1988.
4. R. N. Keshavaurthy and M. Shankar Rao, The Physics of Monsoons, Allied publishers, 1992.
5. G. J. Haltiner and R. T. Williams, Numerical Weather Prediction, John Wiley, 1980.

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MPHY-DSE-401: F. Advanced Electronics (5 Credits)

Course Outcomes (CO):

Students will have understanding of

CO1: Fundamental designing concepts of different types of logic gates, Minimization techniques etc.

CO2: Designing of different types of the Digital circuits, and to give the computational details for Digital circuits.

CO3: Characteristics of devices like PNP, and NPN junction diode and truth tables of different gates.

CO4: Basic elements and to measure their values with multimeter and their characteristic study.

CO5: Working of Flip-flops, registers and counters.

Unit	Topics to be Covered	No. of Hours
I	Operational Amplifiers construction and other linear devices: Building blocks of an OP-AMP: Differential amplifier – dual input, balanced and unbalanced output amplifiers, current sources, current mirror, level transistor, complementary symmetry output, 555 IC timer and its applications, Schmitt trigger, VCO and phase locked loops and their important applications.	20
II	OP-AMP applications: Instrumentation amplifier, logarithmic and exponential amplifiers, analog multiplication, comparators, astable and monostable multivibrators, half wave and full wave precision rectifiers, Active Filters – Second order Butterworth filters – LPF, HPF, narrow band and wide band, band-pass and band-reject filters.	15

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III	Digital Circuits and Combinatorial logic I: Logic Families – TTL and CMOS, construction of basic gates, characteristics, combinatorial Circuits – 2's complement adder and subtractor.	10
IV	Combinatorial logic II: Decoder, encoder, multiplexer, demultiplexer, D/A and A/D convertors.	15
V	Sequential Circuits: Master-slave JK flip-flop, D and T flip-flops, edge triggered flip-flops, Registers and Counters – Shift registers, Bidirectional registers, ripple counters, synchronous counter, up-down counter, decade counter, Johnson and Ring counter.	15

References:

1. S.M. Sze, Physics of Semiconductor Devices, Wiley-Eastern Ltd.
2. Milman and Taub, Pulse, digital and switching Waveforms, McGraw Hill (1965).
3. L. Floyd, Electronic Devices, "Pearson Education", New York (2004).
4. J. Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972).
5. R.A. Gayakwad, Op-Amps & Linear Integrated Circuits, Prentice Hall of India Pvt. Ltd. (1999).
6. Allen Mottershed, Semiconductor Devices and Applications, New Age Int. Pub.

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Generic Elective Course (5 Credits)

MPHY-GE-401: Renewable Energy and Energy Harvesting (5 credits)

Course Outcomes (CO):

The students will be able to

CO1: understand the importance of solar energy and renewable energies.

CO2: understand essential components of renewable energy applications and limitations.

CO3: design renewable energy systems as requirements.

CO4: contribute towards reduction of our dependence on conventional energy sources.

Unit	Topics to be Covered	No. of Hours
I	Fossil fuels and Alternate Sources of Energy Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.	15
II	Solar Energy Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.	15
III	A. Wind Energy Harvesting Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. B. Geothermal Energy Geothermal Resources, Geothermal Technologies.	15

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IV	<p>A. Hydro Energy</p> <p>Hydropower resources, hydropower technologies, environmental impact of hydro power sources.</p> <p>B. Ocean Energy</p> <p>Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.</p>	20
V	<p>A. Piezoelectric Energy Harvesting</p> <p>Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power.</p> <p>B. Electromagnetic Energy Harvesting</p> <p>Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.</p>	20

References:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P. Sukhatme Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004,
5. Oxford University Press, in association with The Open University.
6. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
7. J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
8. http://en.wikipedia.org/wiki/Renewable_energy

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