GURU KASHI UNIVERSITY

Master of Science in Physics
(M.Sc. Physics)

Session: 2023-24

Department of Physics

Graduate Outcomes of the Programme:
The graduates will have the ability to demonstrate advanced independent critical enquiry , have a strong sense of intellectual integrity; have in-depth knowledge of the subject); reach a high level of achievement in writing, research or project activities, problem-solving and communication; be critical and creative thinkers, with an aptitude for continued self-directed learning; have a set of flexible and transferable skills for different types of employment; and The graduates will be able to initiate and implement constructive change in their communities, including professions and workplaces.

Program Learning Outcomes: After completion of the program, the learner will be able to:

1. Apply the knowledge of physics fundamentals to solve complex scientific problems.
2. Identify, formulate and analyze complex scientific problem for higher studies using the principles of Physics.
3. Select, design and apply appropriate experimental techniques with computational tools according to conditions to solve problems of physics.
4. Investigate complex problems of physics using scientific knowledge and research-based knowledge and methods for analysis and interpretation of data.
5. Create, select and apply appropriate techniques, resources, and modern science tools including prediction and modeling to science activities with an understanding of limitations.
6. Apply contextual knowledge to assess societal, health, safety and cultural issues and consequent responsibilities relevant to the science practices.

Course Structure of the Programme

Semester –I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY101	Mathematical Physics	Compulsory Foundation	4	0	0	4
MPY102	Classical Mechanics	Core	4	0	0	4
MPY111	Electronics	Core	4	0	0	4
MPY112	Quantum Mechanics	Core	4	0	0	4
MPY113	Electronics Lab	Skill Based	0	0	2	1
MPY105	Modern Physics Lab	Skill Based	0	0	2	1
Discipline Elective (Any one of the following)						
MPY114	Condensed Matter Physics	Discipline Elective-I	3	0	0	3
MPY115	Radiation Physics					
MPY116	Reactor Physics					
MPY117	Fiber optics and Laser Technology					
Discipline Elective (Any one of the following)						
MPY118	Atomic and Molecular spectroscopy	Discipline Elective-II	3	0	0	3
MPY119	Astronomy and Astrophysics					
MPY120	Renewable Energy Resources					
MPY121	Remote Sensing					
Total			**22**	**0**	**4**	**24**

Semester – II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY212	Classical Electrodynamics	Core	4	0	0	4
MPY213	Thermodynamics and Statistical mechanics	Core	4	0	0	4
MPY214	Nuclear and Particle Physics	Core	4	0	0	4
MPY215	Nuclear and Particle Physics Lab	Skill Based	0	0	2	1
MPY216	Computational Physics	Skill Based	1	0	0	1
MPY217	Computational Physics Lab	Skill Based	0	0	2	1
Discipline Elective (Any one of the following)						
MPY218	Material Science	Discipline Elective-III	3	0	0	3
MPY219	High Energy Physics					
MPY220	Advanced Statistical Mechanics					
MPY221	Advanced Quantum Mechanics					
Discipline Elective (Any one of the following)						
MPY222	Nano Materials	Discipline Elective-IV	3	0	0	3
MPY223	Experimental Techniques in Physics					
MPY224	Electronics Communication					
MPY225	Plasma Physics					
Value Added Course (For other departments also)						
MPY226	Reasoning Aptitude	Value Added Course	1	0	0	1
Total			**20**	**0**	**4**	**22**

Semester-III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY317	Research Methodology	Research Based Skill	4	0	0	4
MPY318	Research Proposal	Research Based Skill	2	0	4	4
MPY319	Ethics and IPR	Interdisciplinary	2	0	0	2
MPY320	Proficiency in Teaching	Skill Based	2	0	0	2
MPY321	Computer Lab	Skill Based	1	0	2	2
MPY322	Service Learning	Community Linkage	0	0	4	2
MPY399	XX	MOOC	--	--	--	4
Total			**11**	**0**	**10**	**20**

Semester-IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY403	Dissertation	Research Based Skill	--	--	--	20
Total			**--**	**--**	**--**	**20**
Grand Total			**53**	**0**	**18**	**86**

Evaluation Criteria for Theory Courses

A. Continuous Assessment: [25 Marks]

CA-1 Surprise Test (Two best out of three) - (10 Marks)

CA-2 Assignment(s) (10 Marks)

CA-3 Term paper /Quiz /Presentation (05 Marks)

B. Attendance (05 marks)

C. Mid Semester Test: [30 Marks]

D. End-Term Exam: [40 Marks]

SEMESTER: I

Course Title: MATHEMATICAL PHYSICS
Course Code: MPY101

L	T	P	Credits
4	0	0	4

Total Hours:60

Learning Outcomes:
After completion of this course, the learner will be able to:
1. Solve differential equations like Legendre, Bessel and Hermite that are common in physical sciences.
2. Solve transfer functions in Instrumentation using Laplace transforms.
3. Apply Fourier transforms in Holography.
4. Apply the knowledge of Tensors to understand phenomenon like stress and strain.

Course Content

Unit-I **13 hours**

Complex Analysis: Cauchy theorem, Cauchy integral representation, Taylor and Laurent series, Liouville's theorem. Morera's theorem, Singular Points and their classification. Branch Point and branch Cut. Riemann sheets. Residues and evaluation of integrals, Cauchy residue theorem and its applications to the evaluation of definite integrals and the summation of infinite series. Integrals involving branch point singularity.

Unit-II **16 hours**

Fourier and Laplace Transforms: Fourier series, Drichlet condition, General properties of Fourier series, Fourier transforms, their properties and applications, Laplace transforms, Properties of Laplace transform, Inverse Laplace transform. Solution of ordinary and partial differential equations by transform methods. Group theory: Group postulates, Lie group and generators, representation, Commutation relations, SU(2), O(3).

Unit-III **16 hours**

Vector and Tensors: Linear vector spaces, subspaces, basis and dimension, Linear independence and orthogonality of vectors, Gram-Schmidt orthogonalisation procedure. Tensor analysis, scalars, Covariant and Contravariant tensors. Addition, Subtraction, Outer product, Inner product and Contraction. Symmetric and anti-symmetric tensors. Quotient law. Metric tensor. Conjugate tensor. Length and angle between vectors. Associated tensors. Raising and lowering of indices. The Christoffel symbols and their transformation laws. Covariant derivative of tensors.

Unit-IV **15 hours**

Differential Equations: Solutions of Hermite, Legendre, Bessel and Laugerre Differential equations, basic properties of their polynomials, and associated Legendre polynomials. Partial differential equations (Laplace, wave and heat equation in two and three dimensions), Boundary value problems and Euler equation. Green's functions for ordinary and partial differential equations of mathematical physics.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion,e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

Suggested Readings:

- *Arfken G, Weber H and Harris F., Mathematical Methods for Physicists, Massachusetts, USA: Elsevier Academic Press.*
- *Kreyszig E., Advanced Engineering Mathematics, New Delhi, India: Wiley India Pvt. Ltd.*
- *Pipes L. A., Applied Mathematics for Engineers and Physicist, McGraw-Hill, Noida,India.*
- *Rajput B. S., Mathematical Physics, Pragati Prakashan*
- *Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, New York*
- *Harper C. Analytical Mathematics in Physics, Prentice Hall.*

Course Title: CLASSICAL MECHANICS

Course Code: MPY102

L	T	P	Credits
4	0	0	4

Total Hours:60

Learning Outcomes:

On completion of this course, the successful students will be able to:

1. Analyze basic mechanical concepts related to discrete and continuous mechanical systems.
2. Solve the equations of motion for complicated mechanical systems using Lagrangian and Hamiltonian formulations of classical mechanics.
3. Explore the application of Hamilton's equations in solving the equation of motion of a particle in a central force field, projectile motion of a body.
4. Apply Newton's laws of motion and conservation laws to solve advanced problems involving the dynamic motion of classical mechanical system.

Course Content

UNIT–I **15 Hours**

Lagrangian formulation: Conservation laws of linear, angular momentum and energy for a single particle and system of particles, Constraints and generalized coordinates, Principle of virtual work, D'Alembert principle, Lagrange's equations of motion, Velocity dependent potential and dissipation function. : Hamilton's principle, Calculus of variations, Lagrange's equations from Hamilton principle. Generalized momentum, Cyclic coordinates, Symmetry properties and Conservation theorems.

UNIT–II **15 Hours**

Hamiltonian formulation: Legendre transformation, Hamilton's equations of motion, Hamilton's equation from Variational principle, Principle of least action. Canonical transformation: Generating function, Poisson brackets and their canonical invariance, Equations of motion in Poisson bracket formulation, Poisson bracket relations between components of linear and angular momenta.

UNIT–III **15 Hours**

Theory of Small Oscillations: Lagrange's equations of motion for smalloscillations, Normal modes, Applications to linear triatomic molecule, Doublependulum and N-Coupled oscillators. Lorentz transformations and its consequences, Relativistic kinematics and mass energy equivalence, Relativistic Lagrangian and Hamiltonian, Four vectors, Covariant formulation of Lagrangian and Hamiltonian.

UNIT–IV **15 Hours**

Continuous systems and Hamilton-Jacoby theory: Transition from discrete to continuous systems, Lagrangian formulation, Stress-energy tensor and conservation laws, Hamiltonian formulation, Scalar and Dirac fields (only definitions). Hamilton-Jacobi equations for Hamilton principal and characteristic functions.

Transaction Mode- - Video Based Teaching, Collaborative teaching, Group Discussion, e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *Goldstein H. Classical Mechanics, Narosa Publishing House, New Delhi.*
- *David Morin,Introduction to Classical Mechanics With Problems and Solutions, Cambridge University Press.*
- *Stephen Thornton, Classical dynamics of particles and systems, Brooks Publishers.*
- *R. Douglas Gregory , Classical mechanics, Cambridge University Press.*
- *Rana N.C., Classical Mechanics, Tata McGraw-Hill, N. Delhi.*

Course Title: Electronics

Course Code: MPY111

L	T	P	Credit
4	0	0	4

Total Hours:60

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Acquire knowledge of operational amplifier circuits and their applications.
2. Analyze the operation of decoders, encoders, multiplexers, adders and subtractors.
3. Explain the working of latches, flip-flops, designing registers, counters, A/D and D/A converters.
4. Design and Analyze synchronous and asynchronous sequential circuits.

Course Content

UNIT–I **15 Hours**

p-n Junction Physics- Fabrication steps; thermal equilibrium condition; depletion capacitance; current-voltage characteristics; charge storage and transient behavior; junction breakdown; hetero junction. Characteristics of some semiconductor devices- BJT, JFET, MOS, LED, Solar cell, Tunnel diode, Gunn diode and IMPATT.

UNIT–II **15 Hours**

Active Circuits: Transistor amplifiers- Basic design consideration; high frequency effect; feedback in amplifiers. Operational amplifiers: device properties, integrator, differentiator, RC active filter, negative and positive feedback, oscillators.

UNIT III **15 Hours**

Number System : Data and number systems, Binary representation, Signed binary number representation with 1's and 2's complement methods, Binary arithmetic. Boolean algebra, Venn diagram, logic gates and circuits, Minimization of logic expressions by algebraic method, K-map method.

UNIT IV **15 Hours**

Combinational and Sequential circuits- adder, subtractor, encoder, decoder, comparator, multiplexer, de-multiplexer, parity generator. Sequential Circuits-

Flip Flops, various types of Registers and counters and their design, Irregular counter, State table and state transition diagram, sequential circuits design methodology. Different types of A/D and D/A conversion techniques.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *Ryder J.D., Electronic Fundamentals and Applications, Prentice Hall of India.*
- *Sze S.M., Semiconductor Devices: Physics and Technology, Wiley Publishers.*
- *Malvino A.P., Digital Principles and Applications, Tata McGraw-Hill, New Delhi.*
- *Hayes & Horowitz, Student Manual for The Analog Electronics; Cambridge University Press.*
- *Boyle'stead & Nashelsky, Electronic Devices & Circuit theory, PHI.*
- *Millman & Halkias: Basic Electronic Principles; TMH.*
- *Tobey & Grame, Operational Amplifier: Design and Applications, Mc Graw Hill*

Course Title: Quantum Mechanics

Course Code: MPY112

L	T	P	Credit
4	0	0	4

Total Hours:60

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Design, set up and carry out experiments; analyze data recognizing and accounting for uncertainties; and compare results with theoretical predictions.
2. Analyze the language of quantum mechanics in 1-dimensional and 3-dimensional problems.
3. Solve Schrödinger equation for simple potentials like linear Harmonic oscillator and Hydrogen atoms.
4. Evaluate CG coefficients for different values of total angular momentum vector.

Course Content

UNIT I **15 Hours**

Motion in a Central Potential and Uncertainty Principle: Solution of the Schrodinger equation for the hydrogen atom, Eigen values and Eigen vectors of orbital angular momentum, Spherical harmonics, Radial solutions,rigid rotator, Solution for three-dimensional square well potential. Generalized uncertainty principle; time energy uncertainty principle, Density matrix.

UNIT II **15 Hours**

Linear vector spaces: Fundamental postulates of quantum mechanics, State vectors, Orthonormality, Hilbert spaces, Linear manifolds and subspaces, Hermitian, unitary and projection operators and commutators; Dirac Bra and Ket Notation: Matrix representations of bras and kets and operators; Continuous basis, Change of basis-Representation theory. Coordinate and momentum representations. Schrodinger, Heisenberg and interaction pictures.

UNIT III **15 Hours**

Linear Harmonic Oscillator: Solution of Simple harmonic oscillator; Vibrational spectra of diatomic molecule; anisotropic three-dimensional oscillator in Cartesian coordinates, Isotropic three-dimensional oscillator in spherical coordinates. Matrix mechanical treatment of linear harmonic oscillator: Energy Eigen values and Eigen vectors of SHO, Matrix representation of creation and annihilation operators, Zero-point energy; Coherent states.

UNIT IV **15 Hours**

Angular momentum: Eigen values, Matrix representations of J2 , Jz, J+, J-; Spin: Pauli matrices and their properties, Addition of two angular momenta: Clebsch-Gordon coefficients and their properties, Spin wave functions for two spin-1/2 system, Addition of spin and orbital momentum, derivation of C.G. coefficients for ½+1/2 and ½+1, addition, Spherical tensors and Wigner-Eckart theorem (Statement only).

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *Thankappan,V.K., Quantum Mechanics, New Age International Publications, New Delhi*
- *Greiner W.,Quantum Mechanics, Springer Verlag Publishers, Germany,*
- *Sakurai J.J.,Modern Quantum Mechanics, Addison Wesley Pub., USA.*
- *Robert Eisberg and Robert Resnick ,Quantum Physics, John Wiley and sons.*
- *D. Bohm, Quantum Theory, Prentice-Hall.*
- *A. K. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, Macmillan India Ltd.*

L	T	P	Credits
0	0	2	1

Course Title: ELECTRONICS LAB

Course Code: MPY113

Total Hours: 30

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Experimentally understand the working of optoelectronic devices.
2. Gain Hands-on experience on verification of circuit laws and theorems.
3. Acquire experimental skills of instrument handling.
4. Apply the basic ideas to create, solve and analyze the problems of interest.

Course Content

1. Study the gain frequency response of a given RC coupled BJT, CE amplifier.
2. Study of Clipping & Clamping circuits.
3. Study of shunt capacitor filter, inductor filter, LC filter and π filter using Bridge Rectifier.
4. Find the energy gap of a given semiconductor by reverse bias junction method.
5. To calculate the temperature coefficient of Thermistor.
6. Verify De-Morgan's law and various combinations of gates using Logic gates circuit.
7. Study of various types of Flip-Flops.
8. To study various Oscillators (Hartley, Colpitt, RC Phase shift etc.).
9. To study Amplitude Modulation and De-Modulation and calculate modulation index.
10. To study characteristics of FET and determine its various parameters.
11. Study the characteristics of Tunnel Diode.
12. To study 2-bit, 3 bit and 4-bit Adder & Subtractor.
13. Study the characteristics of basic Thyristors (SCR, MOSFET, UJT, TRIAC etc.).
14. Use of Transistor as a push pull amplifier (Class 'A', 'B' and 'AB').
15. Application of transistor as a series voltage regulator.
16. Study of biasing techniques of BJT.
17. To study Frequency Modulation and Demodulation.
18. Study of transistor as CE, CB and CC amplifier.
19. Fourier series analysis of square, triangular and rectified wave signal.

Note : Students will perform any 10 experiments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *G. L. Squires, Practical Physics, Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora , Practical Physics, S. Chand &Co.*
- *R.S. Sirohi, Practical Physics,WileyEastern.*

Course Title: Modern Physics Lab

Course Code: MPY105

L	T	P	Credits
0	0	2	1

Total Hours: 30

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Evolve the skills in assessing the quality of one's own and others' work.
2. Apply the principles and skills learned in the classroom to on-the-job practices and
3. Recognize the relationship between the conceptual description of nature and its mathematical expression
4. Estimate sources of error in a measurement.

Course Content

1. To determine Planck's constant using a Photocell
2. To study the characteristics of a phototransistor
3. To study the dependence of energy transfer on the mass ratio of colliding bodies, using air track.
4. To determine the sheet resistance of a Silicon/Germanium wafer using two probe method.
5. To determine the sheet resistance of a Silicon/Germanium wafer using four probe method.
6.To study and the B-H curves of a ferromagnetic and paramagnetic samples on a CRO.
7. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
8. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Ne laser.
9. To study microwave optics system for reflection, refraction, polarization phenomena.
10. To calibrate the prism spectrometer using mercury lamp and to determine the refractive index of material of the prism for a given wavelength of light.
11. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
12. Particle size determination by diode laser.

Note : Students will perform any 10 experiments.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion, e-team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *G. L. Squires, Practical Physics , Cambridge University Press.*
- *Napier Shaw and Richard Glazebrook, Practical Physics, Nabu Press.*
- *C.L. Arora, Practical Physics, S. Chand &Co.*
- *R.S. Sirohi, Practical Physics, Wiley Eastern.*

Course Title: Condensed Matter Physics
Course Code : MPY114

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Analyze the crystal structures, crystal systems and understand the various techniques available using X-Ray crystallography.
2. Synthesize different materials and utilize these materials in different applications according to their properties
3. Categorize the source of a materials magnetic behavior and be able to distinguish types of magnetism and their properties.
4. Infer the phenomenon of superconductivity.

Course Content

UNIT I **12 Hours**

Diffraction methods, Lattice vibrations, Free electrons: Diffraction methods, Scattered wave amplitude, Reciprocal lattice, Brillouin zones, Structure factor, Quasi crystals, Form factor and Debye Waller factor, Bonding of solids, Lattice vibrations of mono-atomic and diatomic linear lattices, IR absorption, Free electron gas in 1-D and 3-D,Heat capacity of metals, Thermal effective mass, Drude model of electrical conductivity, Wiedman-Franz law, hall effect, Quantized Hall effect.

UNIT II **11 Hours**

Semiconductors and Fermi-surfaces in Metals: Band gap, Equation of motion, properties of holes, Effective mass of electrons(m*), m* in semiconductors, Band structure of Si Ge and GaAs, Intrinsic carrier concentration, Intrinsic and extrinsic conductivity, Thermoelectric Effects, Semimetals, Different zone schemes, Constructions of Fermi surfaces, Experimental methods in Fermi surface studies, Quantization of orbits in a magnetic field, De Hass-Van Alphen effect, External orbits, Fermi surfaces for Cu and Au, Magnetic breakdown

UNIT III **11 Hours**

Magnetic properties: Langevin diamagnetism equation, Quantum theory of diamagnetism, Paramagnetism, Quantum theory of para-magnetism, cooling by adiabatic demagnetization, Ferromagnetism, Ferromagnetic domains, Bloch wall, Origin of domains. Magnetization at absolute zero and its temperature dependence, ferrimagnetic order and iron garnets, Anti ferromagnetic order and susceptibility, Anti ferromagnetic magnons.

UNIT IV **11 Hours**

Superconductivity: Survey of traditional and high Tc superconductors, Meissner effect, Heat capacity, Energy gap, Isotope effect, Stabilization energy density, London equations, Coherence length, Some basic ideas of BSC theory, Flux quantization in superconducting ring, Duration of persistent, currents, type II Superconductors, Estimation of HC1 and HC2, Single particle tunneling, DC and AC Josephson effects.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

Suggested Readings :

- *C. Kittel, Introduction to Solid State Physics, Wiley Eastern.*
- *Omar, M.A., ElementarySolid State Physics, Pearson Education.*
- *Srivastva, J.P., Elements of Solid State Physics, Prentice Hall of India.*
- *Ashcroft, N.W. and Mermin, N.D., Solid State Physics, Cengage Learning.*
- *Dekker, A.J., Solid State Physics, Macmillan.*
- *S.H. Patil, Elements of Modern Physics, Springer Cham.*

Course Title: Radiation Physics
Course Code: MPY115

L	T	P	Credit
3	0	0	3

Total Hours: 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Assess the properties of ionizing radiation and their applications
2. Explain the fundamental principles and working of dosimeters
3. Analyze the effects of radiations on human body
4. Infer the elements of radiation shielding and its applications.

Course Content

UNIT I **12 Hours**

Ionizing Radiations and Radiation Quantities: Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement – The free air chamber and air wall chamber. Absorbed dose and its measurement; Bragg Gray Principle, Radiation dose units- rem, rad, Gray and Sievert dose commitment, dose equivalent and quality factor.

UNIT II **11 Hours**

Detectors and Dosimeters: Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors, Radiation detectors - Gas filled counters - general features - ionization chamber, proportional counter and GM counter.Radiation quantities and units - radiation exposure, absorbed dose, equivalent dose and effective dose

UNIT III **11 Hours**

Radiation Interaction with Matter : Interactions of electrons with matter - Specific energy loss, Coulombic mode of interactions, radiative mode of energy loss, electron range and transmission curves.Interaction of gamma rays with matter - Elastic scattering, photoelectric effect, Compton scattering, Klein-Nishina formula (qualitative) and pair production processes, cross section, gamma ray attenuation, linear and mass absorption coefficients.

UNIT IV **11 Hours**

Radiation Shielding and Protection : Thermal and biological shields, shielding, shielding materials, radiation attenuation calculations – The point kernal technique, radiation attenuation from a uniform plane source. Radiation attenuation from a line and plane source. Relative Biological Effectiveness (RBE), Linear energy transformation (LET), Dose response characteristics. Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

Suggested Reading:

- *S.Glasstone and A. Seasonke, Nuclear Reactor Engineering, Springer Publications.*
- *Frederic Alan Smith, Primer In Applied Radiation Physics, World Scientific Publishers.*
- *Knoll G F, Radiation Detection and Measurement, John Wiley*
- *Eisenbud M, Environmental Radioactivity, Academic Press.*
- *Greening J R, Bristol, Adam Hilger, Fundamentals of Radiation Dosimetry, Medical Physics Hand Book*

L	T	P	Credits
3	0	0	3

Course Title: Reactor Physics
Course Code: MPY116

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Explain the neutron moderation process
2. Apply diffusion theory for fusion-fission dynamics
3. Choose materials relevant for reactor design and energy production
4. Categorize different nuclear reactors and nuclear waste management

Course Content

UNIT I **11 Hours**

Neutron moderation: Inelastic scattering, Elastic collisions, moderating ratio, slowing down Density, Resonance escape, Moderatos.

UNIT II **11 Hours**

Fission Process and diffusion theory: Prompt neutrons, Fast fission, Fission energy, Thermal utilization, Fission products, Chain reaction, Multiplication factor, Leakage of neutrons, Critical size, Diffusion and slowing down theory, Homogenous and heterogeneous reactors.

UNIT III **11 Hours**

Materials for Nuclear Reactors: Fuel materials, Moderator and Reflectors, Cladding materials, Coolants and control Rods

UNIT IV **12 Hours**

Type of Power reactors: Boiling water reactors, Pressurized water reactors, Pressurized heavy water reactors, Light water cooled graphite moderated reactors, Gas cooled reactors,, High temperature gas cooled reactors and liquid metal cooled reactors and Fast breeder reactors, Plasma production and its diagnosis, status of fusion reactors.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion, e-team Teaching, Flipped class room teaching, Quiz, Open talk, Case analysis.

Suggested Reading:

- *Glasstons, Sammuel and Sesonske, Alexander, Nuclear reactor Engineer, CBS Publishers & Distributors.*
- *Lamarshs, J.R., Introduction to Nuclear Reactor Theory, Addison-Wesley Publishers.*
- *E.Lewis,Fundamentals of Nuclear Reactor Physics, Academic Press Publishers.*
- *W.M.Stacey, Nuclear Reactor Physics, Wiley-VCH Publishers.*

Course Title: Optical Fiber and Laser Technology

Course Code: MPY117

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Analyze the principles and operation of fibre optic communication System.
2. Evaluate the signal degradation in optical fiber.
3. Categorize different types of optical sources.
4. Assess the applications and characteristics of different optical fibers.

UNIT I **12 Hours**

Structures, Wave guiding and Fabrication of optical fibers : Optical laws and definitions, optical fiber modes and configurations, Mode theory, Step Index and Graded Index (GI) fibers ,single mode and graded index fibers, Derivation for numerical aperture, V number and modes supported by step index fiber, mode field, Numerical aperture and modes supported by GI fibers, fiber materials, linearly Polarized modes fiber fabrication techniques, and mechanical properties of fibers, fiber optic cables.

UNIT II **11 Hours**

Signal Degradation in Optical Fibers: Attenuation, signal distortion in optical waveguides, pulse broadening in graded index fiber, Characteristics of Single Mode Fibers, mode coupling, International Standards for optical transmission fibers.

UNIT III **12 Hours**

Optical Sources: LEDs- structures, materials, Figure of merits, characteristics & Modulation. Laser Diodes -Modes & threshold conditions, Diode Rate equations, resonant frequencies, structures, characteristics and figure of merits, single mode lasers, Modulation of laser diodes, Spectral width, temperature effects, and Light source linearity

UNIT IV **10 Hours**

Applications of optical fibres: Principles of operation, types, characteristics, merits of detectors, photodiode materials, photodetector noise, detector response time, temperature, effects on gain, comparison of photodetectors. Principles of WDM, DWDM, Telecommunications & broadband application, SONET/SDH, MUX, Analog & Digital broadband, optical switching.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Gerd Keiser,Optical Fiber Communication, MGH.*
- *John M. Senior ,Optical Fiber Communications, Pearson Education.*
- *Joseph C Palais, Fiber optic communication, Pearson Education.*
- *Jeff Hecht, Understanding Fiber Optics,Laser Light Press.*

L	T	P	Credits
3	0	0	3

Course Title: Atomic and Molecular Spectroscopy

Course Code: MPY118

Total Hours: 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Apply principles of quantum mechanics to the study of atoms and its behavior.
2. Analyze the spectroscopy of the hydrogen and multi-electron atoms.
3. Evaluate the quantum behavior of atoms in external electric and magnetic fields.
4. Apply general features of atomic and molecular spectroscopic methods in explaining the structure and dynamics of atoms and molecules.

Course Content

UNIT I **12 Hours**

Atomic Physics: One electron atom-spin-orbit interaction, fine structure, Lamb shift, Zeeman effect, Stark effect. Two electron atoms: spin wave functions, approximate handling of electron-electron repulsion. Coupling of angular momenta, multiplet structure, gyromagnetic effects. Hyperfine and nuclear quadrupole interactions. Many electron atoms: central field approximation, Thomas-Fermi and Hartree-Fock methods.

UNIT II **11 Hours**

Molecular Physics: Born-Oppenheimer approximation ,molecular structure, rotation and vibration of diatomic molecules, hydrogen molecular ion, vibrational-rotational coupling, effect of vibration and rotation on molecular spectra. Electronic structure- molecular orbital and valence bond theories.

UNIT III **11 Hours**

UV and IR Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution. The vibrating diatomic molecule as a simple harmonic and a harmonic oscillator, Diatomic vibrating rotator, the vibration-rotation spectrum of carbon monoxide, the interaction of rotation and vibrations.

UNIT IV **11 Hours**

Raman and Electronic Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Electronic Spectroscopy : Electronic structure of diatomic molecule, ,Electronic spectra of diatomic molecules,- The Franck Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, Example of spectrum of molecular hydrogen.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e- team Teaching, flipped classroom Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS

- *H. Haken and H.C. Wolf, Physics of Atoms and Quanta, Springer Publication.*
- *B.H. Bransden and C.J. Joachain, Physics of Atoms and Molecules , Pearson India.*
- *Banwell, Molecular spectroscopy, Tata McGraw Hill Publishers.*
- *Towne and Schawlow, Micorwave Spectroscopy, McGraw-Hill,*
- *Raymond Chang, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo.*
- *D.A. Lang, Raman Spectroscopy, Mc Graw-Hill International, N.Y.*

Course Title: Astronomy and Astrophysics

Course Code: MPY119

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Illustrate the evolution, classification, formation of stars, planets, satellites, and theory of interstellar medium.
2. Explain the structure and population of the Milky Way galaxy, properties of galaxies and its classifications.
3. Analyze the practical aspects of modern observational astronomy.
4. Apply basic physics and computational techniques to solve problems in astrophysics, and interpret the results.

Course Content

UNIT I **10 Hours**

Introduction: Basic concepts of celestial sphere, Co-ordinate systems; Alt-azimuth, Equatorial, Right Ascension, Ecliptic, Basic stellar properties; Luminosity, apparent and absolute magnitude, photo visual and photographic magnitude system, estimation of distance using parallax method and Cepheid variables, stellar masses in binary system. Spectral classification of stars, Origin of emission and absorption spectra, Doppler Effect and its applications.

UNIT II **10 Hours**

Astronomical observations in Interstellar medium and molecular clouds: Structure of our galaxy, Globular clusters, velocity distribution of stars, origin of 21-cm radiation and interstellar gas, fine structure of Carbon, Origin of spiral arms and its basic features, Interstellar dust and theory of extinction of stellar light, molecules and molecular clouds, the galactic magnetic field, the active star forming molecular clouds.

UNIT III **10 Hours**

Stellar evolution and nucleo-synthesis: Pre-main sequence collapse, origin of the solar system, Jean's criteria, Shedding excess of angular momentum and magnetic field, T Tauri phase, Quasi-hydrostatic equilibrium, Virial theorem, Radiative and convective heat transfer, the sun on the main sequence, rates of nuclear energy generation, the standard solar model, evolution of low, intermediate and high mass stars on HR diagram.

UNIT IV **15 Hours**

Cosmology: Simple extragalactic observations, Olber's paradox, Hubble's constant and its implications, the steady state universe, Evolution of the Big Bang, hadron era, lepton era, primordial nucleosynthesis, the radiation era, the matter era, time evolution of the future universe. Tutorials: Relevant problems pertaining to the topics covered in the course.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e- team Teaching, flipped classroom Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS

- *H.S. Goldberg and M.D. Scadron, Physics of stellar evolution and cosmology, Gordon and Breach publishers.*
- *A.E. Roy and D. Clarke, Astronomy: Principles and Practice, Adam Hilger Publishers.*
- *T. Padmanabhan, Theoretical Astrophysics (Vol. I, II, III), Cambridge University Press.*
- *BW Carroll & DA Ostlie, An Introduction to Modern Astrophysics, Latest Edition, Addison-Wesley.*
- *Frank Shu, The Physical Universe, Latest Edition, University Science Books*
- *Martin Harwit, Astrophysical Concepts, Latest Edition, Springer.*

L	T	P	Credits
3	0	0	3

T

Course Title: Renewable Energy Resources

Course Code: MPY120

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Design and assess the small wind turbine and its performance.
2. Enumerate the Small mini Hydro plants for Energy generation.
3. Choose the Hydro power plant capacity for the given circumstances.
4. Develop the basic technological idea about various New & Renewable energy conversion Technology.

Course Content

UNIT I **11 Hours**

Wind Energy Conversion - Wind energy conversion principles; Types and classification of WECS; Site Selection Criteria– Advantages – Limitations – Wind Rose Diagram – Indian Wind Energy Data –Organizations like NIWE etc., Wind Energy Conversion System - Design – Aerodynamic design principles; Aerodynamic theories; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction.

UNIT II **11 Hours**

Design of Wind Turbine - Wind turbine design considerations; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application – Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India.

UNIT III **11 Hours**

Small Hydropower Systems - Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil work

UNIT IV **12 Hours**

Other energy conversion- Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. –SHP – Renovation and Modernization – Testing Methods. OTEC- Tidal Energy- Geothermal- MHD - Thermionic- Thermoelectric energy conversion system- Fuel Cells – Batteries – Micro Alge – Biodiesel from Algae

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion, e- team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *G L Johnson, Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.*
- *David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)*
- *Erich Hau, Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Publications.*
- *Paul Gipe , Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company.*
- *J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained , John Wiley & Sons.*
- *Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi, Wind Energy Handbook ,John Wiley & Sons.*

Course Title: Remote Sensing

Course Code: MPY121

L	T	P	Credits
3	0	0	3

Total Hours:45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Apply the concepts of Photogrammetry to compute the heights of objects.
2. Comprehend the energy interactions with earth surface features, spectral properties of water bodies.
3. Compare the different types of data representation in GIS.
4. Develop models for GIS spatial Analysis and will be able to know what the questions that GIS can answer.

Course Content

UNIT I **11 Hours**

Introduction To Photogrammetry: Principles and types of aerial photographs, geometry of vertical and aerial photograph, Scale and Height measurement on single and vertical aerial photograph, Height measurement based on relief displacement, Fundamentals of Stereoscopy, fiducial points, parallax measurement using fiducial line.

UNIT II **12 Hours**

Remote Sensing: Basic concepts and foundation of Remote Sensing elements, Data information, Remote sensing data collection, Remote sensing advantages and Limitations, Remote sensing process. Electromagnetic spectrum, Energy interaction with atmosphere and with earth surface features (soil, water, and vegetation) Indian Satellites and Sensors characteristics, Map and Image false color composite, introduction to digital data, elements of visual interpretations techniques.

UNIT III **11 Hours**

Geographic Information Systems : Introduction to GIS, Components of GIS, Geospatial data: Spatial Data – Attribute Data- Joining Spatial and Attribute Data, GIS Operations: Spatial Data input- Attribute Data Management-Data Display-Data Exploration-Data Analysis. COORDINATE SYSTEMS: Geographic

Coordinate system; Approximation of Earth, Datum: Map Projections : Types &Parameters.

UNIT IV **11 Hours**

Vector data model: Representation of simple features- Topology and its importance: coverage and its data structure, shape file: data models for composite features Object Based Vector Data Model; Classes and their Relationships: The geo-based data model: Geometric representation of Spatial feature and data structure: Topology rules.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS

- *John R. Jensen, Remote Sensing of the environment- An earth resource perspective, Pearson Education.*
- *Chor Pang Lo, Concepts & Techniques of GIS, Prentice Hall Publications.*
- *Avery, T.E., Interpretation of aerial Photographs. Minneapolis, Minnesota: Burgess Publishing Company.*
- *Bakker, Wim H., et al., Principles of Remote Sensing : An Introductory Textbook. Enschede, The Netherlands: ITC.*
- *Campbell, James B., Introduction to Remote Sensing (Second Edition). London: Taylor & Francis.*
- *Colwell, Robert N.,Manual of Remote Sensing, Second Edition, Volume 1 and 2. Falls Church, Virginia: American Society of Photogrammetry.*
- *S.Kumar, Basics of Remote Sensing and GIS, Laxmi Publications.*

Semester -II

Course Title: Classical Electrodynamics
Course Code: MPY212

L	T	P	Credits
4	0	0	4

Total Hours:60

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Apply Maxwell equations in analyzing the electromagnetic field due to time varying charge and current distribution.
2. Explain the nature of electromagnetic wave and its propagation through different media and interfaces.
3. Illustrate charged particle dynamics and radiation from localized time varying electromagnetic sources.
4. Develop foundation to carry out research in the field of Electrostatics and Magneto-statics.

UNIT–I **15 Hours**

Electrostatics: Differential equation for electric field, Poisson and Laplace equations, formal solution for potential with Green's functions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy

UNIT–II **15 Hours**

Magnetostatics: Continuity equation, Biot-Savart law, Differential equations of magneto statics and Ampere's law, Vector potential and its calculation, Magnetic moment, Macroscopic equations, Boundary conditions on B and E, Magnetic scalar potential. Time varying fields: Faraday's law of electromagnetic induction, Energy in the Magnetic field, Maxwell equations, Displacement current, Electromagnetic potential, Lorentz and Coulomb gauge. Maxwell equations in terms of electromagnetic potentials, Solution of Maxwell equations in Coulomb Gauge and Lorentz gauge by green function.

UNIT–III **15 Hours**

Electromagnetic waves and wave propagation : Poynting theorem and Maxwell stress tensor, Plane waves in a non-conducting medium, Polarization and Stokes parameter, and Energy flux in a plane wave, Reflection and refraction across a dielectric interface, Total internal reflection, Polarization by reflection, Waves in a conducting medium and skin depth.

UNIT–IV **15 Hours**

Radiating Systems: Advanced and retarded green functions; Lienard-Wiechert potentials; dipole radiation and Larmor's formula; spectral resolution and angular distribution of radiation from a relativistic point charge; synchrotron radiation; Rayleigh and Thomson scattering; collision problems; Bremsstrahlung and Cerenkov radiation. Scattering of electromagnetic waves: Rayleigh and Thomson scattering, radiation damping.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion,e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *Jackson, David, Classical Electrodynamics, Wiley India.*
- *Griffiths, David, "Introduction to Electrodynamics, Cambridge University Press.*
- *Edward Mills Purcell and D. J. Morin, Electricity and Magnetism, (3rd ed.), Cambridge University Press.*
- *J.R. Reitz, F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory*
- *W.K.H. Panofsky and M. Phillips, Classical Electricity and Magnetism.*

Course Title: Thermodynamics and Statistical mechanics

Course Code: MPY213

L	T	P	Credits
4	0	0	4

Total Hours:60

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Analyze and solve simple problems related to fundamental ideas of thermodynamics and statistical Physics at micro level in various media.
2. Comprehend the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.
3. Apply the ensemble approach in statistical mechanics to a range of situations.
4. Interpret the knowledge of thermodynamics and statistical Physics at individual particle level.

Course Content

UNIT–I **15 Hours**

Laws of Thermodynamics: Zeroth Law of thermodynamics First law, conversion of heat into work, , Applications of First Law, Second law and Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams. Third law of thermodynamics, unattainability of absolute zero. Thermodynamical Potentials : Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications: Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for (CP and CV). TdS equations.

UNIT–II **15 Hours**

Kinetic Theory of Gases : Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

UNIT–III **15 Hours**

Classical Statistical Mechanics : Postulates, the macroscopic and microscopic states, Liouville's theorem, Van-der Waals equation of state, Phase space, Ensemble, Micro canonical ensemble, Entropy of an ideal gas, Gibb's paradox. Canonical ensemble and its thermodynamics**:** Partition function, Classical ideal gas in canonical ensemble, Energy fluctuations. Equipartition theorem, Grand canonical ensemble and its thermodynamics, Density fluctuations. Equivalence of canonical and the grand canonical ensembles. Ideal gas in grand canonical ensemble. Distribution function, Boltzmann transport equations, Boltzmann's H-theorem, most probable distribution laws, the zero-order approximations, The Navier Stokes equations.

UNIT IV **15 Hours**

Postulates of Quantum Statistical Mechanics: Density matrix, ensembles in quantum statistical mechanics, Ideal Fermi Gas: Equation of state of an Ideal Fermi Gas, Degeneracy, Fermi energy at T=0 and at low temperatures. Bose Gas: Equation of state of an Ideal Bose gas, Bose-Einstein condensation, Density matrix, Equation of motion for density matrix.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion,e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS-

- *Huang K, Statistical Mechanics, John Wiley & Sons Publishers.*
- *Patharia R.K , Statistical Mechanics, Butterworth Oxford Publisher*
- *Fowler, R. H., Statistical mechanics: the theory of the properties of matter in equilibrium' Cambridge: University Press.*
- *H. Gould and J. Tobochnik, Thermal and Statistical Physics, Princeton University press.*
- *Reif, Fundamentals of Statistical and Thermal Physics Paperback, Sarat Book Distributors*

Course Title: Nuclear and Particle Physics

Course Code: MPY214

L	T	P	Credits
4	0	0	4

Total Hours: 60

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Compare the various nuclear models and their applications.
2. Explain the different types of nuclear reactions.
3. Categorize the various elementary particles and their interactions.
4. Construct balanced strong and weak interactions.

Course Content

UNIT I **15 Hours**

Nuclear properties: radius, size, mass, spin, moments, abundance of nuclei, binding energy, semi-empirical mass formula, excited states; Nuclear forces: deuteron, n-n and p-p interaction, nature of nuclear force. Nuclear Models: liquid drop, shell and collective models; Nuclear decay and radioactivity: radioactive decay, detection of nuclear radiation, alpha, beta and gamma decays.

UNIT II **15 Hours**

Nuclear reactions: Different types of reactions, Quantum mechanical theory, Resonance scattering and reactions - Breit-Wigner dispersion relation, optical model, compound nucleus, direct reactions, resonance reactions, fission and fusion.

UNIT III **15 Hours**

Elementary particles: Masses of elementary particles, Decay modes, Classification of these particles, types of interactions. Conservation laws and quantum numbers, Concepts of isospin. Strangeness, Parity, Charge conjugation. Antiparticles, Gell Man method, Decay and strange Particles. Particle symmetry.

UNIT IV **15 Hours**

Fermions and Bosons : particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions. Invariance in classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e- team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Knoll G.F., Radiation Detection and Measurement, John Wiley & Sons.*
- *Krane K.S., Introductory Nuclear Physics, John Wiley & Sons, New York.*
- *I.S. Hughes, Elementary Particles, Cambridge University Press.*
- *F.E. Close, Introduction to Quarks and Partons, Academic Press.*
- *Perkins D. H., Introduction to High Energy Physics, Cambridge University Press.*

Course Title: Nuclear and Particle Physics Lab

Course Code: MPY215

L	T	P	Credits
0	0	2	1

Total Hours : 15

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Acquire knowledge and understanding of fundamental concepts, principles and theories related to nuclear Physics.
2. Develop the skill to combine and use knowledge from several disciplines to propose novel ideas.
3. Collaborate and to lead collaborative work to accomplish a common goal
4. Develop skills to interpret and explain the limits of accuracy of experimental data in terms of significance and underlying theory.

Course Content

1. Study of standard deviation using G-M counter
2. Half-life of ^{40}K using G-M Counter
3. Measurement of mass absorption coefficient of beta rays in given materials
4. To find range and energy of β- particles
5. To find Dead time of a GM Tube
6. Study of energy calibration of NaI (Tl) scintillation detector.
7. Study and analysis of spectrum of ^{137}Cs
8. Verify inverse square law (in case of gamma rays) using scintillation spectrometer
9. Study of Compton scattering law for energy of scattered photons.
10. To study internal conversion coefficient for ^{137}Cs (or suitable gamma source)
11. To determine the source strength of a given radioactive gamma source
12. Study and analysis of spectrum ^{60}Co
13. Photoelectric cross-section measurement for a given target material at known incident gamma photo energy
14. Compton cross-section measurement for known incident gamma photon energy
15. Measurement of Photo-peak (full energy peak) efficiency of Scintillator detector

Course Title: Computational Physics

Course Code: MPY216

L	T	P	Credits
1	0	0	1

Total Hours:15

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop the skills for solving nonlinear system by various methods, incorporating scientific programming languages.
2. Design solution to any physical problem regarding Physics and computational Physics.
3. Apply various integration and differential methods for solving linear and polynomial system
4. Analyze the utility of 2nd and 4th order Runge-Kutta method

Course Content

UNIT I **3 Hours**

Root finding Methods: Convergence and terminal conditions, Efficient computations Bisection method, Secant method, Regula Falsi method, Newton Raphson method, Newton's method for solving nonlinear systems.

Unit-II **4 Hours**

Elimination methods: Gauss elimination method (with row pivoting) and Gauss–Jordan method, Gauss Thomas method for tri-diagonal systems Iterative methods: Jacobi and Gauss Seidel iterative methods.

Unit-III **3 Hours**

Interpolation and extrapolation Methods: Piecewise polynomial interpolation: Linear interpolation, Cubic spline interpolation (only method), Numerical differentiation: First derivatives and second order derivatives.

Unit -IV **5 Hours**

Integration and differential Methods: Trapezoid rule, Simpson's rule (only method), Newton–Cotes open formulas Extrapolation methods: Romberg integration, Gaussian quadrature, Ordinary differential equation: Euler's method Modified Euler's methods: Heun method and Mid-point method, Runge-Kutta second methods: Heun method without iteration, Mid-point method and Ralston's method Classical 4th order Runge-Kutta method, Finite difference method for linear ODE.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, e-team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Laurence V. Fausett, Applied Numerical Analysis, Using MATLAB, Pearson.*
- *M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific*
- *Engineering Computation, New Age International Publisher.*
- *Steven C Chapra, Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata McGraw Hill.*
- *Rajaraman, V. Computer Oriented Numerical Methods Printice-Hall.*

Course Title: Computational Physics Lab

Course Code: MPY217

L	T	P	Credits
0	0	2	1

Total hours:15

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop the skills for solving nonlinear system by various methods, incorporating scientific programming languages.
2. Design solution to any physical problem regarding Physics and computational Physics.
3. Apply various integration and differential methods for solving linear and polynomial system
4. Analyze the utility of 2nd and 4th order Runge-Kutta method

Course Content

1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.
2. Choose a set of 10 values and find the least squared fitted curve.
3. Generation of waves on superposition like stationary waves and beats.
4. Fourier analysis of square waves.
5. To find the roots of quadratic equations.
6. Wave packet and uncertainty principle.
7. Find first order derivative at given x for a set of 10 values with the help of Lagrange interpolation.
8. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.
9. Perform numerical integration on 1-D function using Simpson and Weddle rules.
10. To find determinant of a matrix - its eigenvalues and eigenvectors.

SUGGESTED READINGS :

- *Numerical Mathematical Analysis, J.B. Scarborough (Oxford Book Co.) 4th edition.*
- *A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition.*
- *Computer Applications in Physics: S. Chandra (Narosa)2nd edition.*

- *Computational Physics: R.C.Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 1st edition.*
- *Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 2nd edition.*

Course Title: Material Science

Course Code: MPY218

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Analyze the ideas of basics of structure of material properties and bonding characteristics of materials and their energy.
2. Demonstrate the phase rules and properties of phase diagram
3. Construct binary isomorphous diagram from cooling curves
4. Compare various types of ceramics on the basis of their properties.

Course Content

UNIT I **12 Hours**

Structure of solids: Introduction to engineering materials, Description of materials science tetrahedron, Structure - description of unit cell and space lattices, Coordination number, APF for cubic and hexagonal close packed structures. Significance of structure property correlations in all classes of engineering materials. Diffusion phenomenon: Diffusion in ideal solutions, Kir kendall effect, Rate and mechanism of diffusion, Fick's first and second law of diffusion, Applications of diffusion, Concept of uphill diffusion.

UNIT II **11 Hours**

Principles of solidification and phase equilibria: Concept of free energy and entropy; Structure of liquid metals; Energetics of solidification; Nucleation and growth, Homogeneous and heterogeneous nucleation, Dendritic/Equiaxed growth, Origination of grain and grain boundaries, Cast structure; Significance of alloying, Intermediate alloy phases, solid solutions and its types

UNIT III **11 Hours**

Phase diagrams and phase transformations: Basic definitions; Gibbs phase rule, Introductions to binary, ternary and quaternary system; Construction of binary isomorphous diagram from cooling curves, Time scale for phase diagrams, Transformations in steels, Precipitation process, recrystallization andgrowth.

UNIT IV **11 Hours**

Heat treatment: TTT curves, CCT curves, Annealing, Normalising, Hardening, Tempering Ceramics: Introduction to ceramic materials; Classification of ceramics, Crystal structure and bonding of common advanced ceramic materials; Mechanical behavior of ceramics, Glass and glass ceramics: Preparation and characterisation of ceramics powders; Applications of ceramics in advanced technologies.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e--team teaching, Group discussion e- team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *W. D. Callister, Materials Science and Engineering: An Introduction, John Wiley & Sons.*
- *C. Kittel, Introduction to Solid State Physics, Wiley Eastern Ltd.*
- *V. Raghavan, Materials Science and Engineering: A First Course, Prentice Hall.*
- *S.H. Avener, Introduction to Physical Metallurgy Tata McGraw-Hill Education.*
- *V. Raghavan, Materials Science & Engineering: A first course,PHI Learning.*
- *W.D. Kingery, Introduction to Ceramics, John Wiley & Sons.*

Course Title: High Energy Physics

Course Code: MPY219

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes

After completion of this course, the learner will be able to:

1. Apply conservation laws to write balanced strong and weak interactions.
2. Infer the phenomenon of resonance and parity violation.
3. Analyze the Higgs Mechanism and its applications.
4. Asses the recent developments in high energy physics.

Course Content

UNIT I **12 Hours**

Symmetry properties: General features of conservation laws in quantum theory, Parity conservation, Operators and transformation, Isospin, G-parity, Conservation of Isospin, Generalized Pauli principle; Conservation laws: Baryon and lepton and flavor non-conservation. Positronium decay, Application of Isospin conservation to NN interaction and strong-decays.

UNIT II **11 Hours**

Resonances: Observation and properties of Resonances; Tau-theta problem, Observation of Tau-lepton and new flavors., Parity violation in weak interaction, K^0-K bar mixing, C and CP violation, CPT theorem (statement only).

UNIT III **11 Hours**

Gauge theories of fundamental interactions: Higgs Mechanism and its application in gauge theories, Elements of QED, Global and local gauge invariance, Feynman diagrams, Successes of QED; Current-current interaction and V-A theory, Cabibbo modification. Introduction to GSW model and limitations of QED. Strong interaction theory of quarks and gluons (QCD),

UNIT IV **11 Hours**

Recent Expansions in HEP : Supersymmetry, extra dimensions, neutrino oscillations and link with cosmology (QUALITATIVE TREATMENT ONLY).

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e--team teaching, Group discussion e- team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *D.J. Griffiths, Introduction to Elementary Particles, Wiley-VCH Publishers.*
- *D.H.Perkins, Introduction to High Energy Physics,Cambridge University Press.*
- *F. Halzen and A D Martin, Quarks and Leptons, John Wiley & Sons.*
- *T Ferbal, Experimental Techniques in High Energy Nuclear and particle Physics:World Scientific Press.*
- *F. Sauli, Instrumentation in High Energy Physics, World Scientific Press.*
- *D.M. Ritson,Techniques of High Energy Physics, Interscience Publishers.*

Course Title: Advanced Statistical Physics

Course Code: MPY220

L	T	P	Credits
3	0	0	3

Total Hours :45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Construct density matrix for various physical problems.
2. Discuss the phenomenology of first- and second-order phase transitions with particular reference to the Ising model and liquid-gas transition.
3. Evaluate the expectations of random variables with the Langevin equation.
4. Formulate Langevin and Fokker-Planck equations in simple cases.

Course Content

UNIT I **10 Hours**

Interacting Systems: Deviation of a real gas, Cluster expansion for a classical gas, Virial expansion of equation of state, Evaluation of virial coefficients, General remarks on cluster expansion; quantum mechanical ensemble theory, the density matrix, density matrix for a linear harmonic oscillator; cluster expansion for a quantum mechanical system. Bose condensation.

UNIT II **10 Hours**

Phase Transitions and Critical Phenomena: Phase transitions – General remarks on the problems of condensation, Dynamical model for phase transition— Ising and Heisenberg models, the lattice gas and binary alloy, Ising model in the Zeroth approximation, Matrix method for onedimensional Ising model. The critical indices, Law of Corresponding States, thermodynamic inequalities, Landau's phenomenological theory; Scaling hypothesis.

UNIT III **10 Hours**

Brownian motion: Spatial correlation in a fluid, Einstein-Smoluchowski theory, Langevin theory, The Fokker-Planck equation.

UNIT IV **15 Hours**

The Time Correlation Function Formalism: Concept of time correlation function, derivation of basic formulas of linear response theory, Time-Correlation function expressions for thermal transport coefficients and their applications. The Wiener - Khintchine theorem, the fluctuation dissipation theorem. The Onsagar relations.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e--team teaching, Group discussion e- team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *Huang K., Statistical Mechanics, John Wiley & Sons Publishers.*
- *Patharia R.K.,Statistical Mechanics, Butterworth Oxford Publishers*
- *Fowler, R. H., Statistical mechanics: the theory of the properties of matter in equilibrium, Cambridge: University Press.*

Course Title: Advanced Quantum Mechanics

Course Code: MPY221

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Apply time independent and time dependent perturbation theories to solve different problems.
2. Models physical systems applying various approximation methods.
3. Explain the formalism of relativistic quantum mechanics.
4. Demonstrate basic concepts of scattering amplitude, symmetries in scattering and to solve scattering problems, to work with partial wave analysis.

Course Content

UNIT I **15 Hours**

Perturbation Theory: Time independent perturbation theory for non-degenerate levels, first order Zeeman Effect in H-atom, second order Zeeman Effect in H-atom, Hydrogen Molecule– Heitler-London Treatment Time dependent perturbation theory, Fermi Golden Rule, Harmonic perturbation, Application of Time dependent theory to Alpha-Scattering and ionization of Hydrogen atom, Adiabatic and Sudden perturbations.

UNIT II **10 Hours**

W.K.B. Approximation and Variational Method: The W.K.B. Approximation, validity of W.K.B. Approximation, Turning points and Connection formulae, TheVariational Method, Applications of Variational Method– Ground state energy of hydrogen atom, normal state of helium atom and Zero point energy of one dimensional harmonic oscillator.

UNIT III **10 Hours**

Relativistic Quantum mechanics: Schrodinger's Relativistic equation, Probability and current densities, Klein-Gorden equation in presence of electromagnetic field, Application of Klein-Gorden equation to hydrogen atom. Dirac's Relativistic equation for a free electron, Free particle solution, Negative energy states, Probability and current densities, Dirac's equation in electromagnetic field, Dirac's equation in a central field— the electron spin, spin orbit energy, Covariance of Dirac's equation.

UNIT IV **10 Hours**

Scattering Theory: Scattering Amplitude of Spinless Particles, Scattering Amplitude and Differential Cross Section, First Born Approximation, Validity of the First-Born Approximation.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e--team teaching, Group discussion e- team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Thankappan, V.K. , Quantum Mechanics, New Age International Publications, New Delhi,*
- *. Mathews P.M. and Venkatesh K.,Quantum Mechanics, Tata-McGraw Pub., New Delhi.*
- *Greiner W., Quantum Mechanics, Springer Verlag Publishers, Germany.*
- *Sakurai J.J., Modern Quantum Mechanics, Addison Wesley Pub., USA.*

Course Title: Nano Materials

Course Code: MPY222

L	T	P	Credits
3	0	0	3

Total Hours: 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Analyze the internal structure of materials, atoms and Crystals.
2. Conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
3. Demonstrate the application of diffusion in sintering and doping of semiconductors.
4. Interpret mechanical properties of materials and optical properties of Materials.

Course Content

UNIT I **15 Hours**

Introduction: Definition of a nano system - classification of nanocrystals - dimensionality and size dependent phenomena; Quantum dots, Nanowires and Nanotubes, 2D films; Nano & mesopores – top down and bottom up- Misnomers and misconception of Nanotechnology importance of the nanoscale materials and their devices -size dependent variation in mechanical, physical and chemical, magnetic, electronic transport, reactivity.

UNIT II **10 Hours**

Synthesis Of Nanomaterials:Physical Vapour Deposition (PVD), Inert gas condensation, Arc discharge, DC sputtering, Ion sputtering, RF & Magnetron sputtering ,Pulse Laser Deposition (PLD), Ball Milling, Molecular beam epitaxy, Electro-deposition, Metal nanocrystals by reduction, Sol- gel, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Nanocrystals of semiconductors and other materials by arrested precipitation, Thermolysis routes, Liquid-liquid interface.

UNIT III **10 Hours**

Nano-Electronic Technologies: Nano capacitors, Quantum tunneling, Single electron transistors, Coulomb blockade, Nano lithography, Data storage, Nanophotonics, Nano electronic and Magnetic devices, Spintronic, Carbon based materials: Carbon Nano-tube (CNC), Graphene. Sensors & Nano-sensors.

UNIT IV **10 Hours**

Application of Nanomaterial : Sustainable energy technologies Solar energy, Hydrogen energy and Nano-materials, Carbon nanotube fuel cells, Hydrogen storage, Thermoelectricity, Re-chargeable batteries, Energy savings, Nano-lubricants, Nano-composites and Nano-catalysts.

Transaction Mode- Video Based Teaching, Collaborative teaching, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis

SUGGESTED READINGS

- *S. Shanmugam, Nanotechnology, TBH Edition.*
- *T. Pradeep, Nano-the essential, Mc graw hill education, Chennai.*
- *Kenneth J. Klabunde, Nanoscale Materials, Wiley& Sons Publication.*
- *Masaru Kuno, Introductory Nanoscience, Garland Science Publications.*
- *Bharatbhushan,Handbook of Nanotechnology, Springer Publications.*

Course Title: Experimental Techniques in Physics

Course Code: MPY223

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop skills for the preparation of thin films using various methods.
2. Compare various thickness measurement and characterization techniques.
3. Categorize the different types of transducers.
4. Classify different vacuum pumps on the basis of their applications.

Course Content

UNIT I **15 Hours**

Introduction and Preparation Methods: Basic of Thin films and nanostructures, Role of thin films in Devices . Physical methods: Thermal evaporation, Cathodic sputtering, Molecular beam epitaxy and Laser ablation methods. Chemical methods: Electrolytic deposition, Chemical vapor deposition

UNIT II **10 Hours**

Thickness Measurement and Characterization: Electrical, Mechanical, Optical, Microbalance, Quartz crystal methods and Analytical techniques of characterization: X-ray diffraction, Electron microscopy, High and low energy electron diffraction, Auger emission spectroscopy.

UNIT III **10 Hours**

Transducers and Temperature Measurements: Classification of transducers, Selecting a transducer, qualitative treatment of strain gauge, capacitive transducers, inductive transducers, linear variable differential transformer (LVDT), photoelectric transducers, piezoelectric transducers, temperature measurements (Resistance thermometer, thermocouples, Thermistors).

UNIT IV **10 Hours**

Vacuum& Low Temperature Techniques: Vacuum techniques, Basic idea of conductance, pumping speed, Pumps: Mechanical pumps, Diffusion pumps, Ionization pumps, turbo molecular pumps, gauges; Penning, Pirani, Hot cathode, Low temperature: Cooling a sample over a range up to 4 K and measurement of temperature.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e--team teaching, Group discussion e- team Teaching, Flipped classroom Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *Cooper W.D. and Helfrick A.D.,Electronic Instrumentation and Measurement Techniques, Prentice Hall of India Pvt. Ltd.*
- *Herzberg G., Molecular Spectra and Molecular Structure, Van Nostrand Publishers.*
- *Dr. PatilShriram B, Experimental Physics, Wordit Content Design & Editing Services Pvt Ltd.*
- *Rao, V. V., Gosh, T. B., & Chopra, K. L.,Vacuum science andTechnology, Allied Publishers.*
- *Glang, R., Maissel, L. I.,Handbook of Thin Film Technology, Leon*
- *I. Maissel and Reinhard Glang, McGraw-Hill Book Company.*
- *Chopra, K. L.,Thin film phenomena. R. E. Krieger Publishing Company.*
- *George, J., Preparation of thin films. CRC Press.*

Course Title: Electronics Communication

Course Code: MPY224

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Apply the concepts of the analog communication systems to real world problems.
2. Evaluate modulation index, bandwidth and power requirements for various analog modulation schemes including AM,FM and PM.
3. Analyze various analog continuous wave modulation and demodulation techniques including AM, FM and PM.
4. Explain the influence of noise over Analog Modulation schemes through random process and noise theory and applications of Analog communication techniques.

Course Content

UNIT I **12 Hours**

Introduction to communication systems: Information, transmitter, channel noise, receiver, need for modulation, bandwidth requirements. Noise and its types. Evolution and description of single side band, suppression of carrier, the balanced modulator, suppression of unwanted side band, pilot carrier systems, ISB systems, VSB transmission, single and independent side band receivers.

UNIT II **11 Hours**

Amplitude Modulation : Representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-superhetrodyne receivers, communication receivers.

UNIT III **11 Hours**

Frequency Modulation : Description of FM systems, mathematical representation, frequency spectrum, phase modulation, intersystem comparison, pre-emphasis and de-emphasis, comparison of wide band and narrow band FM, stereophonic FM multiplex system, FM generation techniques, FM demodulators, FM receivers.

UNIT IV **11 Hours**

Pulse Communication: Information theory, pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PWM transmission system, PCM transmission system, telegraphy and telemetry.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

1. Simon Haykin,An Introduction to Analog and Digital Communications, John Wiley Sons Publishers.
2. G. Kennedy and B. Devis, Electronic communication systems, Tata McGraw Hill Publishers.
3. W. Tomasi, Electronic communication systems, Pearson Education Asia.

Course Title: Plasma Physics

Course Code: MPY225

L	T	P	Credits
3	0	0	3

Total Hours 45

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Explain the plasma state and the various parameters characterizing them.
2. Analyze the motion of charged particles in electric and magnetic fields
3. Make estimates of various parameters in plasmas
4. Explain the properties of the most important wave modes in plasma.

Course Content

UNIT I **12 Hours**

Basics of Plasmas: Occurrence of plasma in nature, Debye shielding and plasma parameter. Single particle motions in uniform E and B, non-uniform magnetic field, grad B and curvature drifts, invariance of magnetic moment and magnetic mirror. Boltzman equation: Fluid model of a plasma, Two fluid and one fluid equations, Collision less Boltzman equation, Moment equations and conservation laws, Transport phenomena in plasma: Fokker Planck equations.

UNIT II **11 Hours**

Motion of charged particles: Motion of charged particles in a constant uniform magnetic field, Constant and uniform electric and magnetic fields, Inhomogeneous magnetic field. Constant non-electromagnetic forces, Time varying magnetic field, constant magnetic and time varying electric field, Adiabatic invariants, Magnetic mirrors.

UNIT III **11 Hours**

Magneto hydrodynamics: Generalized Ohm's law, MHD equations, MHD equilibrium, Force free fields. MHD Stability: Normal mode technique, Sausage and kink instability in a linear pinch, Energy principle, Interchange instabilities, Cusp configuration, two stream, Ion-acoustic drift, Firehose instabilities.

UNIT IV **11 Hours**

Waves in Plasma: Plasma oscillations, Electron plasma waves, Ion waves, Electrostatic electron and ion oscillations in a magneto-plasma, Electromagnetic waves propagation through a plasma and magneto-plasma, Alfven waves and magneto-sonic waves.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, E-team teaching, Group discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READING:

- *Donald A. Gurnett, Introduction to Plasma Physics, Cambridge University Press*.
- *S.N.Sen,Plasma Physics, Pragati Publications.*
- *Basudev Ghosh,Basic Plasma Physics,Narosa Publishing House*

Course Title: Reasoning Aptitude

Course Code: MPY226

L	T	P	Credits
1	0	0	1

Total Hours :15

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop skill to meet the competitive examinations for better job opportunity.
2. Enrich their knowledge and to develop their logical reasoning thinking ability.
3. Draw conclusions or make decisions in quantitatively based situations that are dependent upon multiple factors.
4. Analyze the Problems logically and approach the problems in a different manner.

UNIT I **3 Hours**

Verbal reasoning: Para – Jumble, Analogy, Series Completion test, Inserting a missing character, Alphabet test, Logical Sequence of Words.

UNIT II **3 Hours**

Non-verbal reasoning: Series, Analogy, Incomplete figures, paper folding, Embedded figure, Dot fixing situation, paper cutting.

UNIT III **4 Hours**

Analytical reasoning: Sets based on games like Cricket, Football, Hockey, Tennis etc.Share trading. Sitting Arrangement – Linear, Circular, Directions & Ranking, Blood Relations, Sets based on Playing cards.

UNIT IV **5 Hours**

Logical reasoning: Number series, Alpha Numeric Letter and Symbol Series, Numerical and Alphabet Puzzles, Seating arrangements.

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion,e- team Teaching, Flipped

Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS

- *R.S. Agarwal, A Modern Approach to Verbal & Non-Verbal Reasoning, S Chand Publishing.*
- *MK Pandey, Analytical Reasoning,Bsc Publishing Co. Pvt. Ltd.*
- *B.S. Sijwali, A New Approach to Reasoning Verbal & Non-Verbal, Arihant Publications.*

Semester III

L	T	P	Credits
4	0	0	4

Course Title: Research Methodology

Course Code: MPY317

Total Hours :60

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.
2. Know the main approaches in legal methodology, have basic knowledge on qualitative research techniques
3. Acquire adequate knowledge of the key issues of disciplinary and interdisciplinary legal research.
4. Develop an adequate literature review and identify relevant references to formulate a theoretical framework in accordance with the research topic.

Course Content

UNIT I **15 Hours**

Research: its concept, nature, scope, need and Objectives of Research, Research types, Research methodology, Research process – Flow chart, description of various steps, Selection of research problem.

UNIT II **15 Hours**

Research Design: Meaning, Objectives and Strategies of research, different research designs, important experimental designs,

Methods of Data Collection and Presentation: Types of data collection and classification, Observation method, Interview Method, Collection of data through Questionnaires, Schedules, data analysis and interpretation, editing, coding, content analysis and tabulation.

UNIT III **15 Hours**

Sampling Methods: Different methods of Sampling : Probability Sampling methods , Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling and Multistage Sampling. Non probability Sampling methods, Sample size.

UNIT IV **15 Hours**

Report writing and Presentation: Types of reports, Report Format – Cover page, Introductory page, Text, Bibliography, Appendices, Typing instructions, Oral Presentation

Transaction Mode- Video Based Teaching, Collaborative teaching, Project based learning, e-team teaching, Group discussion, e- team Teaching, Flipped Teaching, Quiz, Open talk, Problem Analysis.

SUGGESTED READINGS :

- *Panneerselvam R , Research Methodology, PHI, New Delhi.*
- *Cooper, D.R.,Schindler, P.S., Business Research Methods, Tata McGraw Hill .*
- *Gupta S P,Statistical Methods, Sultan Chand & Sons, Delhi.*
- *Ronald E Walpole, Probability and Statistics for Engineers and Scientist, Pearson Education.*
- *Geode, Millian J. & Paul K. Hatl, Methods in Research, McGraw Hills, NewDelhi.*
- *Kothari C.R., Research Methodology, New AgePublisher*
- *Nargundkar R, Marketing Research, Tata McGraw Hill.*
- *Sekran, Uma, Business Research Method, Miley Education,Singapore.*
- *https://www.academia.edu/*
- *https://www.studeersnel.nl*
- *https://www.scribd.com.*

L	T	P	Credits
2	0	4	4

Course Title: Research Proposal

Course Code: MPY318

Total Hours : 30

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Develop research questions and hypotheses.
2. Frame critical literature review, using well developed analytical and synthesis skills.
3. Explain research design, and be able to choose rigorous and practical research methods to address a problem focused research question(s).
4. Formulate present and write a research proposal, using high level written and verbal communication skills.

Course Content

The research proposal is a document of around 3000-4000 words outlining the research the students will undertake. Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study. Regardless of the research area and the methodology students choose, all research proposals must address the following questions:

What students plan to accomplish, why they want to do it and how they are going to do it.

Introduction:

I. Topic area
II. Research question
III. Significance to knowledge

Make sure the proposal starts on a general level with some type of introductory remarks before going into the details of the specific research question you are proposing. This can be accomplished by providing
a frame of reference, a definition, or a discussion of the significance of the topic in the field. Make sure the research question is fully stated in one place.

Literature Review:

I. Previous research: others & yours
II. Interlocking findings and unanswered questions
III. Your preliminary work on the topic

IV. The remaining questions and inter-locking logic
V. Reprise of your research question(s) in this context

The literature review demonstrates the applicant's knowledge of the main research achievements in the area of study. Pay attention to provide some of the key references in your area of research which requires doing extensive research on your part. Make sure whether you can easily determine how the proposal is building on earlier studies, as well as exploring a line of research that is new.

Methodology / Theoretical Framework:

I. Approach
II. Data needs
III. Analytic techniques
IV. Plan for interpreting results
V. Expected results

Provide a full description of your general research design, as well as the specific methods and procedures used in your research project. This section discusses what measures the researcher will take in order to
test the study's hypothesis.

i) Describe your theoretical approach or type of analysis, if applicable
ii) Explain the details of your methods

Objectives:

i) Give a concise and clear outline of what you intend to find out in your project and what objectives you want to achieve.
ii) Research questions may take the form of a hypothesis to be tested against a specific set of criteria or a more open-ended inquiry.
iii) Objectives should establish the relevance and value of the proposed research in the context of current academic thinking.
iv) Your proposal needs to show why the intended research is important and to justify the reason for doing the research.

References:

Provide a list of all references that you have cited in the proposal.

L	T	P	Credits
2	0	0	2

Course Title: Ethics & IPR
Course Code: MPY319

Total Hours :30

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Explain different kind of ethics and values.
2. Apply professional ethics in research.
3. Explain the role of IPRs in professional life.
4. Elucidate the importance of patents and copyrights.

Course Content

UNIT I **10 Hours**

Ethics:definition, moral philosophy, nature of moral judgments and reactions, scope, Ethics with respect to science and research, Intellectual honesty and research integrity Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP) Redundant publications: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data, Publication ethics: definition, introduction and importance.

UNIT II **10 Hours**

Introduction to Intellectual Property rights: Concept & theories, Kinds of intellectual Property Rights, Advantages & Disadvantages of IPR, Development of IPR in India, Role & Liabilities of IPRs in India. Rights of trademark-kind of signs used as trademark-types, purpose & functions of a trademark, trademark protection, trademark registration, selecting and evaluating trade mark, trade mark registration process.

UNIT III **5 Hours**

Patents: Introduction to Patents, Object of Patent Law, Inventions not Patentable, Obtaining Patents, Rights and Obligations of a Patentee.

UNIT IV **5 Hours**

Databases and Research Metrics: Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, Altmetrics, Google Scholar, Research Gate, Pub-med etc.

SUGGESTED READINGS :

- *Narayanan, P., Intellectual Property Law, Eastern Law House.*
- *Tripathi A.N., Human Values, New Age International (P) Ltd.*
- *Robbins, S.P., Organizational Behavior, Prentice Hall of India.*
- *Journal of Intellectual Property Rights, published by National Institute of Science Communication, CSIR.*

Course Title: Proficiency in Teaching
Course Code: MPY320

L	T	P	Credits
2	0	0	2

Total Hours :30

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Design the learner-centered instructional plans and learning outcomes.
2. Apply innovative teaching strategies and technologies to engage learners.
3. Analyze the different assessment methods to evaluate student learning.
4. Develop effective communication and classroom management skills.

Course Content

UNIT I **10 Hours**

Overview of the course and its objectives - Theories of learning and their implications for teaching - Understanding the role of the teacher and student in the learning process - Writing clear and measurable learning outcomes.

Meaning Nature, definition, scope, and importance Pedagogy, Andragogy, and Heutagogy – Skills-based approach to teaching (Teaching skills), Micro-teaching, Macro teaching. Methods and approaches of teaching - CAM, Structure-function approach, Synthetic and Analytic approach, Jurisprudential inquiry model

UNIT II **6 Hours**

Understanding the diverse needs and backgrounds of learners - Creating an inclusive and supportive learning environment - Facilitating active learning and student engagement strategies

Lectures, discussions, and demonstrations - Group work, collaborative learning, and cooperative learning - Problem-based learning, case studies, and simulations

UNIT III **7 Hours**

Integrating technology tools into instruction – Online, blended learning, flipped learning, and M-learning approaches - Using educational software and platforms effectively.

Formative and summative assessment methods – Difference between Assessment, Evaluation and Measurement, E-assessment tools,

UNIT IV **7 Hours**

The importance of reflective practice in teaching - Self-assessment and evaluation of teaching effectiveness –Need for Professional development -

Teaching in multicultural and international classrooms - Culturally responsive teaching practices.
Meaning, Definition of teaching model - Assumptions, Importance, Role, and type of teaching models. Historical teaching model, Philosophical model of teaching

Transaction Mode : Discussions, Case Studies, Microteaching, Classroom Observations, Peer Teaching: Video Analysis, Role-Playing, Lecture-cum-demonstration, Classroom Simulations, Reflective Journals/Blogs, Teaching Portfolios and Technology Integration, Flipped Teaching.

SUGGESTED READINGS :

- *Ali, L. (2012). Teacher education. New Delhi: APH Publishing Corporation*
- *Anandan, K. (2010). Instructional technology in teacher education. New Delhi: APH Publishing Corporation.*
- *Bruce R Joyce and Marsha Weil, Models of Teaching, Prentice Hall of India Pvt Ltd, 1985.*
- *Chalan, K. S. (2007). Introduction to educational planning and management. New Delhi: Anmol Publications Pvt. Ltd.*
- *Chand, T. (2008). Principles of teaching. New Delhi: Anmol Publications Pvt. Ltd.*

Course Title: Computer Lab
Course Code: MPY321

L	T	P	Credits
1	0	2	2

Total Hours :30

Learning Outcomes:

After completion of this course, the learner will be able to:
1. Apply MATLAB effectively to analyze and visualize data.
2. Apply numeric techniques and simulations to solve physics-related problems.
3. Interpret and visualize simple mathematical functions and operations there on using plots.
4. Learn graphics and programming in MATLAB.

Course Content

UNIT I **8 Hours**

Basic Operations of MATLAB: MATLAB Fundamentals, Introduction- MATLAB Features-Desktop Windows: Command, Workspace, Command History, Array Editor and Current Directory -MATLAB Help and Demos- MATLAB Functions, Characters, Operators and Commands.

UNIT II **7 Hours**

Basic Arithmetic in MATLAB-Basic Operations with Scalars, Vectors and Arrays-Matrices and Matrix Operations-Complex Numbers- MATLAB Built-In Functions-Illustrative Examples.

UNIT III **7 Hours**

MATLAB Programming : Control Flow Statements: if, else, else if, switch Statements-for, while Loop Structures-break Statement-Input/output Commands-Function m Files-Script m Files-Controlling Output MATLAB Graphics.

UNIT IV **8 Hours**

2D Plots : Planar Plots, Log Plots, Scatter Plots, Contour Plots-Multiple Figures, Graph of a Function, Titles, Labels, Text in a Graph- Line Types, Marker types, Colors-3D Graphics-Curve Plots-Mesh and Surface Plots-Illustrative Examples.

SUGGESTED READINGS

- *Chapman, S., "MATLAB Programming for Engineers",Cengage Learning, Engineering, 1120 Birchmount Rd, Toronto, ON, M1K5G4, Canada.*
- *Register, A.H., "A guide to MATLAB object-oriented programming", Boca Raton, FL: CRC Press.*
- *Brian Hunt, Ronald Lipsman, Jonathan Rosenberg, "Guide to MATLAB for Beginners & Experienced Users",Cambridge University Press.*

Course Title: Service Learning

Course Code: MPY322

L	T	P	Credits
0	0	4	2

Total Hours :30

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Explain the meaning of service learning and active learning.
2. Illustrate engaged teaching and engaged research
3. Attain greater levels of civic behavior and social responsibility;
4. Develop greater commitment to a service-oriented career.

Course Content

Service learning: principles of service learning; classification of service-learning models; difference between service learning and other community experiences; historical context of university community partnership; physics students and service learning. Service Learning for a postgraduate physics student and its scope in research.

Conceptualization of the idea of service learning through the following practical implementations:

(i) conducting awareness programs on scientific temper for nearby communities,

(ii) organizing demonstrations of scientific experiments for school children to eradicate the fear of pursuing higher studies in science,

(iii) surveying the need of the communities and find out various possibilities of providing the solutions from physics point of view

(iv) providing consultancy to school students for various inter school science competitions.

(v) providing video lectures and/or demonstrations for school students.

Semester IV

Course Title: Dissertation

Course Code: MPY403

L	T	P	Credits
0	0	0	20

Learning Outcomes:

After completion of this course, the learner will be able to:

1. Gain in-depth knowledge and use adequate methods in the major subject/field of study.
2. Create, analyze and critically evaluate different technical/research solutions
3. Clearly present and discuss the conclusions as well as the knowledge and arguments that form the basis for these findings
4. Identify the issues that must be addressed within the framework of the specific dissertation in order to take into consideration

Course Content

The aim of dissertation in M.Sc. 4th semesters is to expose of the students to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. Dissertation can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about 30 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the GKU.

Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc. as per guidelines prepared by the GKU.

Credits for Final Dissertation Report & Viva Voce: 20

All the candidates of MCA final project are required to submit a project report based on the work done by him/her during the project period. A student will submit his/her project report in the prescribed format. A student has to submit: two hard copies of the project report, and a soft copy of project on

CD/DVD in a thick envelope pasted inside of the back cover of the dissertation report.

Prescribed outline for the Dissertation Report

1. Title Page (format as in Anenxure-1)
2. Declaration (format as in Anenxure-1)
3. Certificate from the Project Guide on letter head of an organization (format as in Anenxure-1)
4. Acknowledgement
5. Abstract
6. Index
7. List of Figures
8. List of Tables
9. List of acronyms and abbreviations
10. Introduction to the project
11. Statement of the Problem
12. Theoretical Background / Literature review
13. Experimental details.
14. Results
15. Conclusions and Future Work
16. References
17. Annexure (optional)

Formatting Instructions:

Margins: Left margin-1.3-inch, Right margin-1-inch, Top margin: 1-inch, Bottom margin:1 inch Page numbers–All pages should be numbered at the bottom center of the pages.

Normal Body Text: Font Size: 12, Times New Roman, 1.5 Spacing, Justified. 6 point above and below paragraph spacing. Section Heading: Font Size: 14, Times New Roman, Underlined, Left Aligned. 12 point above & below spacing.

Chapter Heading: Font Size: 20, Times New Roman, Centre Aligned, 30 point above and below spacing.

Figure and Table Captions: Font Size: 12, Times New Roman, centered.

Coding Font: size: 10, Courier New, Normal Good quality white paper A4 size should be used for typing and duplication.

This load (equivalent to 2 hours per week) will be counted towards the normal teaching load of the teacher.