GURU KASHI UNIVERSITY

Master of Science in Physics

Session : 2022-23

Department of Physics

PROGRAMME OUTCOMES: After completion of the program, the students 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 modelling to science activities with an understanding of limitations.

Programme Structure

Semester –I						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY101	Mathematical Physics	Core	4	0	0	4
MPY102	Classical Mechanics	Core	4	0	0	4
MPY103	Classical Electrodynamics	Core	4	0	0	4
MPY104	Analog Electronics	Core	4	0	0	4
MPY105	Modern Physics Lab	Skill Based	0	0	4	2
MPY106	Computer Programming Lab I	Skill Based	0	0	4	2
MPY107	Radioactivity & its implications for environment & society	Community Outreach	0	0	4	2
Value Added Course (For other departments also)						
MPY108	Reasoning Aptitude	Value Added Course	2	0	0	2
MPY109	Communication Skills	Ability Enhancement	0	0	2	1
MPY199		MOOC	-	-	-	-
Total			**18**	**0**	**14**	**25**

Semester – II						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**

MPY201	Quantum Mechanics	Core	4	0	0	4
MPY202	Atomic and Molecular Spectroscopy	Core	4	0	0	4
MPY203	Statistical Mechanics	Core	4	0	0	4
MPY204	Lasers and Optics Lab	Skill Based	0	0	4	2
MPY205	Computer Programming Lab II	Skill Based	0	0	4	2
MPY206	Nanotechnology	Field Based	0	0	2	1
MPY207	Physics In Everyday Life	Community Outreach	0	0	2	1
Discipline Elective (Any one of the following)						
MPY208	Condensed Matter Physics	Discipline Elective – I	4	0	0	4
MPY209	Remote Sensing					
MPY210	Astrophysics					
MPY211	Neutron Physics					
Total			**16**	**0**	**12**	**22**

Semester-III						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY301	Digital Electronics	Core	4	0	0	4
MPY302	Nuclear and Particle Physics	Core	4	0	0	4
MPY303	Advanced Quantum Mechanics	Core	4	0	0	4
MPY304	Electronics Lab	Skill Based	0	0	4	2
MPY305	MATLAB Programming Lab	Skill Based	0	0	4	2
Discipline Elective (Any one of the following)						
MPY306	Advanced Statistical Mechanics	Discipline Elective- II	4	0	0	4
MPY307	Plasma Physics					
MPY308	Radiation Physics					
MPY309	Reactor Physics					
Discipline Elective (Any one of the following)						
MPY310	Material Science	Discipline Elective-III	4	0	0	4
MPY311	High Energy Physics					
MPY312	Electronic Communication					

	Physics					
MPY313	LASER Physics					
Open Elective Courses (For other Departments)						
MPY314	General Physics	IDC	2	0	0	2
MPY315	Physics for competitive exams					
MPY316	Disaster Management					
MPY399		MOOC	--	--	--	--
Total			**20**	**0**	**8**	**26**

Semester-IV						
Course Code	**Course Title**	**Type of Course**	**L**	**T**	**P**	**Credit**
MPY401	Experimental Techniques in Physics	Research skill	4	0	0	4
MPY402	Research Project Analysis	Research Skill based	NA	NA	NA	20
MPY403	Environmental Management	Value Added Course	2	0	0	2
Total			**4**	**0**	**0**	**26**
Grand Total			**61**	**0**	**34**	**98**

<u>Evaluation Criteria for Theory Courses</u>

A. Continuous Assessment: [25 Marks]

i. Surprise Test (Two best out of three) - (10 Marks)
ii. Term paper (10 Marks)
iii. Quiz (10 Marks)
iv. Assignment(s) (10 Marks)
v. Attendance (5 marks)

B. Mid Semester Test-1: [30 Marks]
C. MST-2: [20Marks]
D. End-Term Exam: [20 Marks]

Evaluation Criteria for other courses has been given separately with the respective courses

SEMESTER: 1st

Course Title: MATHEMATICAL PHYSICS

Course Code: MPY101

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Explain the origin of Legendre polynomial, Bessel functions and Hermite polynomial and use their properties in relevant problems.
2. Demonstrate contour integrals& tensor analysis in relevant problems in Physics
3. Use the mathematical functions in physical simulation, engineering filed and mathematical modeling. This will help students to get job in R&D and research industry.
4. Derive the fundamentals and applications of Fourier series, Fourier and Laplace transforms, their inverse transforms etc.

Course Contents

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, Dirichlet 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 Space: Linear vector spaces, subspaces, basis and dimension, Linear independence and orthogonality of vectors, Gram-Schmidt orthogonalisation procedure.

Tensors: Tensor analysis, scalars, Covariant and Contravariant tensors. Addition, Subtraction, Outer product, Inner product and Contraction. Symmetric and antisymmetric 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:-

1. Arfken G, Weber H and Harris F. (2012), "Mathematical *Methods for Physicists*", Massachusetts, USA: Elsevier Academic Press.
2. Kreyszig E. (2011), "*Advanced Engineering Mathematics*", New Delhi, India: Wiley India Pvt. Ltd.
3. Pipes L. A. (1985), "*Applied Mathematics for Engineers and Physicist*", McGraw-Hill, Noida,India,

Course Title: CLASSICAL MECHANICS

Course Code: MPY102

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Formulate the Lagrangian mechanics concepts and solve the problems with the help of Lagrangian mechanics.
2. Solve the problems of generating function, canonical transformation & Poisson brackets.
3. Explain the foundations of relativistic physics, Maxwell inhomogeneous equations and conservation laws.
4. Illustrate the Hamilton Jacobi equations and characteristic functions, Action and angle variable, small oscillations, application

Course Contents

UNIT–I **Hours: 15**

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 **Hours: 15**

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 **Hours: 15**

Special theory of relativity: Lorentz transformation, Length contraction, Time dilation, Twin Paradox, Variation of mass with velocity, Transformation of relativistic momentum-,velocity and energy, relation between relativistic momentum and energy. Invariance of Space-time interval, covariant formulation, Force, momentum and energy equation in relativistic mechanics, Lagrangian formulation of relativistic mechanics, Michelson Morley experiment, Relativistic Kinematics and mass-energy equivalence.

UNIT–IV **Hours: 15**

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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:-

1. Goldstein H. (2001), "*Classical Mechanics*", Narosa Publishing House, New Delhi.
2. Gupta K.C. (1988), "*Classical Mechanics of Particles and Rigid Bodies*", John Wiley Publishers.
3. Rana N.C. (1991), "*Classical Mechanics*", Tata McGraw-Hill, N. Delhi.

Course Title: CLASSICAL ELECTRODYNAMICS
Course Code: MPY103

L	T	P	Credits
4	0	0	4

Total Hours:60

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

1. Use Maxwell equations in analyzing the electromagnetic field due to time varying charge and current distribution.

2. Describe the nature of electromagnetic wave and its propagation through different media and interfaces.
3. Explain charged particle dynamics and radiation from localized time varying electromagnetic sources.
4. Build a foundation for the students to carry out research in the field of Electrostatics and Magneto-statics.

Course Contents

UNIT–I **Hours: 15**

Radiating Systems: Fields of radiation of localized oscillating sources, electric dipole fields and radiation, magnetic dipole and electric quadrupole fields, central fed antenna, brief introduction to radiation damping and radiation reaction. Fields of Moving Charges: LienardWiechert potential, field of a moving charge. Radiated power from an accelerated charge at low velocities, Larmour's power formula and its relativistic generalization.

UNIT–II **Hours: 15**

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 **Hours: 20**

Multipoles and dielectrics: Green's function and solution of Poisson equation, Addition theorem of spherical harmonics, Dirac delta function in spherical polar coordinates, Eigen function expansion of green function, Solution of potential problems with spherical green function expansion, Multipole expansion, Microscopic and macroscopic fields, Equations of electrostatic field in a dielectric, bound charge densities, Molecular polarizability, Electrostatic energy in dielectric media.

UNIT–IV **Hours: 10**

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.

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

SUGGESTED READINGS:-

1. Jackson, David. (1998), "Classical Electrodynamics", Wiley India.
2. Griffiths, David. (2017), "Introduction to Electrodynamics", Cambridge University Press.
3. Edward Mills Purcell and D. J. Morin (2013), Electricity and Magnetism, (3rd ed.), Cambridge University Press

Course Title: ANALOG ELECTRONICS

Course Code: MPY104

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Comprehend the working of Different Semiconductor devices (Construction, Working Principles and V-I characteristics) and their applications.
2. Demonstrate the working of amplifiers, Transistors and feedback in Amplifiers and transistors.
3. Describe Basic operational amplifier characteristics, OPAMP parameters, applications as inverter, integrator, differentiator etc.
4. Get the skills to operate general communication system and satellite –mobile communication system.

Course Contents

UNIT–I **Hours: 15**

Semiconductor Devices: Growth of semiconductor crystals, Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors; Effect of temperature and doping on Carrier concentration and their mobility, Drift and diffusion of carriers, Fabrication of p-n junction, Qualitative description of current flow at a junction, Diffusion and depletion capacitance of p-n junction. MOSFET Enhancement and depletion mode. Comparison of JFETs and MOSFETs. Thyristor, SCR, TRIAC, DIAC, UJT, Photo-conductive devices, Photo-conductive cell, Photodiode, LCD.

Microwave Devices: Thermistor. Gunn diode, Zener diode. IMPATT and TRAPATT devices, PIN diode, Tunnel diode.

UNIT–II **Hours: 15**

Operational amplifiers: Ideal operational amplifier. Inverting and non-inverting amplifiers. Differential amplifiers. CMMR. Internal circuit of operational amplifier. Examples of practical operational amplifier. Operational amplifier characteristics. DC and AC characteristics, slew rate. Difference and Common mode gain, Common Mode Rejection Ratio, Operational Amplifier as Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator. Comparator, Schmitt trigger, Multivibrators, Mono Stable & Astable, Square wave & Triangular wave Generators.

UNIT–III **Hours: 15**

Two port network analysis: Active circuit model's equivalent circuit for BJT, Trans conductance model: Common emitter. Common base. Common collector amplifiers. Equivalent circuit for FET. Common source amplifier. Source follower circuit.

Feedback in amplifiers: Stabilization of gain and reduction of non-linear distortion by negative feedback. Effect of feedback on input and output resistance. Voltage and current feedback.

Bias for transistor amplifier: Fixed bias circuit, Voltage feedback bias. Emitter feedback bias, Voltage divider bias method, Bias for FET.

UNIT–IV **Hours: 15**

Active filters: Sallen-key and Multiquad Configurations for LP, HP, BP filters, Active BR and AP filters.

Power Devices: pnpn devices, SCR and trigger applications.

Communication systems: General communication system, Generation and detection of amplitude modulated, Single-side band, and Double-side band suppressed carrier and Frequency modulated wave. ASK, PSK and FSK, Satellite and mobile communication - TDMA, FDMA, CDMA.

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

SUGGESTED READINGS:-

1. Ryder J.D. (1975), "*Electronic Fundamentals and Applications*", Prentice Hall of India (5th Ed.), New Delhi.
2. Sze S.M. (1985), "*Semiconductor Devices: Physics and Technology*", Wiley Publishers.
3. Malvino A.P. (2014), "*Digital Principles and Applications*", Tata McGraw-Hill, New Delhi.

Course Title- Modern Physics Lab
Course Code: MPY105

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Develop 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 Contents

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 the characteristics of a astablemultivibrator

7. To determine the band gap and activation energy of a semiconductor p-n junction diode
8. To study the various applications of a SCR (Buzzer, switch etc.)
9. To make an electronic voting machine using simple AND/OR/XOR logic gate circuits
10. To study the characteristics of a given voltage doubler and tripler
11. To verify the law of conservation of linear momentum in collision using air track
12. To study the oscillations in a rectangular potential well, using air track
13. To study the characteristics of Colpitts Oscillator
14. To study the characteristics of Hartley Oscillator
15. To study the disturbed capacity of a given inductance coil
16. To study and the B-H curves of a ferromagnetic and paramagnetic samples on a CRO.

Note : Students will perform any 10 experiments.

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 READINGS:-

1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.
2. R.S. Sirohi,(2012), *Practical Physics*, , WileyEastern.

Course Title: Computer Programming Lab I
Course Code: MPY106

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Gain the skill of solving physics problems using programming languages.
2. Use computers effectively to solve problems through numerical methods.
3. Design solution to any physical problem with the use of coding and language knowledge.
4. Analyze physical problems from obtained output.

Course Contents

List of Practical's:

1. To print even and odd number between given limit.
2. To generate prime numbers between given limit.
3. To construct Fibonacci series.
4. To find maximum and minimum number among a give data.
5. To find area of a triangle.
6. To find factorial of a number
7. To find roots of a quadratic equation.
8. To construct AP and GP series.
9. To construct Sine and Cosine series.
10. Conversion of temperature scale.
11. Addition of two matrices.
12. Motion of horizontally throw projectile.
13. Find mean and standard deviation of a given data.
14. To find perfect number

Note: Each student is required to perform at least ten

xperiments

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 READINGS:-

1. Bjarne Stroustrup(2013), *Programming: Principles and Practice*,Addison Weley.
2. Yashavant P Kanetkar (2020), *Let us C*,BPB Publications.

Course Title: Radioactivity & its Implications for Environment & Society

Course Code: MPY107

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Understand the nature and origin of radioactive elements.
2. Explain decay processes in our environment.

3. Learn about the implications of radiation for biological systems and our environment.
4. Analyze use of radiation for an increasing number of human activities and its broader societal impact.

Course Contents

UNIT I **Hours 5**

The phenomenon of radioactivity: The discovery of radioactivity, the nature and detection of radioactivity, the physics of radioactive decay, Natural and induced radioactivity, Dosimetry and exposure limits, the biological impact of radioactivity

UNIT II **Hours 8**

The origin of radioactivity : The origin of the elements, the radioactive universe, the radioactive earth, Geological implications and consequences, The human radioactivity cycle, The origin and evolution of life**.**

UNIT III **Hours 8**

The environmental impact of radioactivity : Atmospheric Radioactivity, Radioactivity in agriculture, Radioactivity in building materials, Radioactivity and natural resources, Radioactivity and renewable energy, Radioactivity and nuclear energy.

UNIT IV **Hours 9**

Societal impact of radioactivity: Radioactivity in the industrial production process, Radioactivity in the art market, Radioactivity and medical applications, Radioactivity and homeland security, Radioactivity in war, Radioactivity and fear.

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:

1.Michael F. L'Annunziata (2007), *Radioactivity: Introduction and History*, Elsevier Science.
2. VladoValkovic (2020), *Radioactivity in the Environment*, Elsevier Science.

Course Title: Reasoning Aptitude
Course Code: MPY108

L	T	P	Credits
2	0	0	2

Total Hours: 15

Course Outcomes: On completion of this course, the successful students 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 **Hours 3**

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

UNIT II **Hours 3**

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

UNIT III **Hours 4**

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 **Hours 5**

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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:

1.R.S. Agarwal(2018), *A Modern Approach to Verbal & Non-Verbal Reasoning*, S Chand Publishing.
2.MK Pandey(2009), *Analytical Reasoning*,Bsc Publishing Co. Pvt. Ltd.
3. B.S. Sijwali (2014), *A New Approach to Reasoning Verbal & Non-Verbal,* Arihant Publications.

Course Title: Communicative Skills

Course Code: MPY109

L	T	P	Credits
0	0	2	1

Total Hours: 15

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

1. Brighten their awareness of correct usage of English grammar in writing and speaking.
2. Improve their speaking ability in English both in terms of fluency and comprehensibility.
3. Upgrade their reading speed and comprehension of academic articles
4. Enhance fluency in reading skills through extensive reading, enrich their vocabulary, and refine ability to write academic papers, essays and summaries.

Course Contents

UNIT –I **Hours: 4**

Developing Habits of Independent and Fast Reading: Students will be required to read a prescribed prose. The essays in the anthology will be read by students at home with the help of glossary given in the book. Progressing from one lesson to another, they should learn to read fast. Students are supposed to keep a record of their reading in the form of notes, difficulties, summaries, outlines and reading time for each essay. Class teacher may use this record for awards of internal assessment (if any)

UNIT -II **Hours: 4**

Developing Comprehension Skills: Teacher will provide guided comprehension of the prescribed texts in the class and help students in answering the questions given at the end of each lesson. Teacher can construct more questions of factual and inferential nature to enhance the comprehension skills of the students. The teacher shall also guide students to do the grammar exercise given at the end of each lesson.

UNIT -III **Hours:3**

Developing skills in Personal Writing: Students will be required to learn short personal write-ups involving skills of description and narration. The types of composition task may include personal letter writing, telegram writing. Notice writing, diary writing etc. The teacher shall instruct the students about the appropriate format and usual conventions followed in such writings. The teacher may also prescribe composition /writing book if so required.

UNIT -IV **Hours:4**

Development of Speaking Skills: Public speaking – formal speaking-audience analysis – effective use of voice & body language – importance of confidence building – group discussion – presentation skills- seminar – interview skills development – telephone etiquettes – opinion based speaking.

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

SUGGESTED READINGS:-

1. Vandana R Singh. (2003) "*The Written Word*" Oxford University Press New Delhi.
2. KK Ramchandran, Etal. (2002). "*Business Communication*". Macmilan. New Delhi.
3. Swati Samantaray. (2001) "*Business Communication and Communicative English*". Sultan Chand, New Delhi.

SEMESTER – 2nd

Course Title: Quantum Mechanics
Course Code: -MPY201

L	T	P	Credits
4	0	0	4

Total Hours: 60

Course Outcomes: On completion of this course, the successful students 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. Demonstrate angular momentum operators associated with spherical and symmetrical systems. -summarize ceramics and its types and relate their applications with properties.
4. Get employment in different LED companies, communication industry and quantum computing and R& D sector.

Course Contents

UNIT I **Hours 15**

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 **Hours 15**

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 **Hours 15**

Linear Harmonic Oscillator: Solution of Simple harmonic oscillator; Vibrational spectra of diatomic molecule; anisotropicthree-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 **Hours 15**

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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:

1. Thankappan,V.K. (1996), *Quantum Mechanics*, New Age International Publications, New Delhi
2. Greiner W. (1994), *Quantum Mechanics*, Springer Verlag Publishers, Germany,
4. Sakurai J.J. (1999), *Modern Quantum Mechanics*, Addison Wesley Pub., USA.

Course Title: Atomic and Molecular Spectroscopy

Course Code: MPY202

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Analyze different atomic structure and will be able to understand fine-structure and hyperfine- structure spectra.
2. Explain rotational and IR spectroscopy and apply the techniques of microwave and infrared spectroscopy to analyze the structure of atoms and molecules.
3. To develop the skills to solve real physical problems using various spectroscopic techniques.
4. Understand the change in behavior of atoms in external applied electric and magnetic field.

Course Contents

UNIT I **Hours 15**

Spectra of one and two valance electron systems: Larmor's theorem; Space quantization of orbital, spin and total angular momenta; Vector model for one and two valance electron atoms; Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology; Level scheme for two electron system- L-S and J-J couplings; Interaction energy in L-S and J-J coupling for two electron systems; Selection and Intensity rules for doublets and triplets.

UNIT II **Hours 15**

Molecular Structure: Molecular potential, Separation of electronic and nuclear wave functions, Born-Oppenheimer approximation, Molecular orbital and electronic configuration of diatomic molecules: H2, and NO, LCAO approach, States for hydrogen molecular ion, Coulomb, Exchange and overlap integral, Shapes of molecular orbital, Sigma and pi bond.

UNIT III **Hours 15**

Microwave Spectroscopy: Types of molecules, Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven,

Infra-Red Spectroscopy 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, Outline of technique and instrumentation, Fourier transform spectroscopy.

UNIT IV **Hours 15**

Raman Spectroscopy: Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy,

Electronic Spectroscopy Electronic structure of diatomic molecule, ,Electronic spectra of diatomic molecules, Born Oppenheimer approximation- 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

<u>SUGGESTED READINGS:</u>

1. H. Haken and H.C. Wolf(2005), *Physics of Atoms and Quanta*, Springer Publication.
2. B.H. Bransden and C.J. Joachain (2003), *Physics of Atoms and Molecules* , Pearson India.
3. Banwell(1995), *Molecular spectroscopy*, Tata McGraw Hill Publishers.

Course Title: Statistical Mechanics

Course Code: MPY203

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Analyze the logical frame work of testing of hypothesis and based on the acquired knowledge to interpret the meaning of the calculated statistical indicators.
2. Comprehend the fundamental differences between classical and quantum statistics and learn about quantum statistical distribution laws.
3. Grasp the basis of ensemble approach in statistical mechanics to a range of situations.
4. Use the skills to competently employ a whole host of formalisms of statistical mechanics to a variety of problems in physics, chemistry, biology, computer science, economics and several other disciplines.

Course Contents

UNIT I **Hours 15**

Classical Statistical Mechanics : Postulates, the macroscopic and microscopic states, contact between statistics and thermodynamics, connection between statistical and thermodynamic quantities, Liouville's theorem, Van-der Waals equation of state,Phase space, Ensemble, Micro canonical ensemble, Entropy of an ideal gas, Gibb's paradox.

UNIT II **Hours 15**

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 III **Hours 15**

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.

UNIT IV **Hours 15**

Phase transition: First order phase transition: the Clausius Clapeyron equation, Ising model in zeroth approximation, fluctuations in: canonical and grand canonical ensembles, random walk and Brownian motion.

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

SUGGESTED READINGS :

1. Huang K. (2008), *Statistical Mechanics*, John Wiley & Sons Publishers.

2.Patharia R.K. (1996), *Statistical Mechanics*, Butterworth Oxford Publishers

3. Fowler, R. H. (1929). *Statistical mechanics: the theory of the properties of matter in equilibrium'* Cambridge: University Press.

Course Title: Lasers & Optics Lab
Course Code: MPY204

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Gain Practical knowledge of various measurement methods using lasers.
2. Get familiarize with the basics of experimental physics.
3. Explore the concepts involved in the working of optical instruments.
4. Develop skills for analyzing data and interpret results.

Course Contents

1. To study the optical bench model of microscope and to determine the numerical aperture of the microscope.
2. To study the optical bench model of telescope and to determine the angular field of view and magnifying power by entrance and exit pupil method.
3. To study the characteristics of solar cell.
4. To study the magnetostriction in an iron rod using Michelson interferometer.
5. To study the optical thickness of mica sheet using channel spectrum interferometry.
6. To determine the Planck's constant using photovoltaic cell.

7. To obtain the coherence matrix and stokes parameters for (I) unpolarized light (ii) polarized light and hence to determine their degree of polarization.
8. To study the aberrations of a convex lens.
9. To study the electro-optic effect in LiNbO3 crystal using He-Ne laser.
10. To study B-H curve.
11. To study the characteristics of optoelectronic devices (LED, Photodiode, Photodiode, Phototransistor, LDR).
12. To study the diffraction pattern by pin hole, single slit, double slit and grating and to calculate the wavelength of He-Ne laser.
13. To study microwave optics system for reflection, refraction, polarization phenomena.
14. 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.
15. Measurement of Brewster angle and refractive index of materials like glass and fused silica (with He-Ne laser) with a specially designed spectrometer.
16. Particle size determination by diode laser.
17. Study of optical fiber communication kit.

Note: Students will perform any 10 experiments.

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 READINGS:-

1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.
2. R.S. Sirohi,(2012), *Practical Physics*, , WileyEastern.

Course Title: Computer Programming Lab II
Course Code: MPY205

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Acquire the skill of solving physics problems using programming languages.
2. Use computers effectively to solve problems through numerical methods.
3. Design solution to any physical problem regarding physics and computational physics.
4. Analyze physical problems from obtained output.

Course Contents

Any ten of the following physics problems:

1. To generate frequency distribution table.
2. Solution of a differential equation by RK2 method.
3. Solution of a differential equation by RK4 method.
4. To find area under a curve by Trapezoidal Rule and Simpson's Rule.
5. Gauss elimination method.
6. Multiplication of two matrices.
7. Motion of projectile thrown at an angle.
8. Numerical Solution of equation of motion.
9. Simulation of planetary motion.
10. Root of an equation by Newton-Raphson method.
11. Sorting numbers by selection sort.
12. Fitting straight line through given data points.
13. Roots of an equation by secant method.
14. Newton interpolation.

Note: Each student is required to perform at least 10 experiments.

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 READINGS:-

1. Bjarne Stroustrup (2013), *Programming: Principles and Practice*, Addison Weley.

2. Yashavant P Kanetkar (2020), *Let us C,* BPB Publications.

Course Title: Nanotechnology

Course Code: MPY206

L	T	P	Credits
0	0	2	1

Total Hours: 30

Course Outcomes: On completion of this course, the successful students 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 Contents

UNIT I **Hours 4**

Nanoscale systems: Introduction to Nanoscale – Size-Dependent properties - Size effect - surface tension, wettability - specific surface area and surface area to volume ratio – Reason for change in optical properties, electrical properties and mechanical properties – nanoscale catalysis.

UNIT II **Hours 3**

Synthesis of nanostructure materials: Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD)- chemical vapor deposition (CVD) - Sol-Gel- Ball milling –spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis.

UNIT III **Hours 2**

Quantum dots: Preparation through colloidal methods-Epitaxial methods-MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements.

UNIT IV **Hours 1**

Applications of nanotechnology: Nano diodes, Nano switches, molecular switches, quantum dots based white LEDs – CNT based transistors –Surface acoustic wave (SAW) devices, microwaves MEMS.

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

SUGGESTED READINGS:

1. S. Shanmugam, *Nanotechnology*, TBH Edition.
2. T. Pradeep, *Nano-the essential*, Mc graw hill education, Chennai.
3. Kenneth J. Klabunde (2001), *Nanoscale Materials*, Wiley& Sons Publication.

Course Title: Physics in Everyday Life

Course Code: MPY207

L	T	P	Credits
0	0	2	1

Total Hours 30

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

1. Explain physics related phenomenon using basic physics principles and terminology
2. Perform basic calculation/estimations to solve simple physics related problems
3. Make correct judgement/decisions on physics related issues in their daily life based on basic physics principles.
4. Understand the importance of physics in everyday life.

Course Contents

UNIT I **Hours 3**

Transportation: Linear motion, Speed, velocity, acceleration, Force, Newton's laws, circular motion, friction, collision, energy and momentum

Sports: Force, energy, projectile motion, rotation, moment of inertia, angular momentum

UNIT II **Hours 3**

Weather and climate: Energy, heat and temperature, the first law thermodynamics, heat transfer, black body radiation.

UNIT III **Hours 2**

Home Electricity: Electrostatics, electric potential, current, and resistance, ohm's law, electric power, refrigeration, electric safety.

UNIT IV **Hours 2**

Green Energy : Electricity as energy, Electromagnetic Induction, thermal power generation, heat engine, nuclear power, solar power, wind power, biofuels

SUGGESTED READING:

1. Louis A. Bloomfield (2006), "*How Things Work- The Physics of Everyday Life*", John Wiley & Sons.

Course Title: Condensed Matter Physics

Course Code: MPY208

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Analyze the crystal structures, crystal systems and understand the various techniques available using X-Ray crystallography.
2. Learn the skills to synthesize different materials and utilize these materials in different applications according to their properties
3. Identify the source of a materials magnetic behavior and be able to distinguish types of magnetism and their properties.
4. Describe the phenomenon of superconductivity: key experiments, some attempts to explain superconductivity, the BCS model
5. Illustrate the fundamentals of dielectric and ferroelectric properties of materials

Course Contents

UNIT-I **Hours: 15**

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, Neutron scattering, 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 **Hours:15**

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 **Hours:15**

Magnetic properties: Langevin diamagnetism equation, Quantum theory of diamagnetism, Paramagnetism, Quantum theory of para-magnetism, magnetism of rare earth and iron group ions, cooling by adiabatic demagnetization, Ferromagnetism, Magnetization at absolute zero and its temperature dependence, ferrimagnetic order and iron garnets, Anti ferromagnetic order and susceptibility, Anti ferromagnetic magnons, Ferromagnetic domains, Bloch wall, Origin of domains, Application of soft and hard magnetic materials. Ferro-electric materials and their classification.

UNIT-IV **Hours:15**

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. Macroscopic quantum interference, SQUIDS and its application.

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

SUGGESTED READINGS:-

1. C. Kittel (2003), *Introduction to Solid State Physics,* Wiley Eastern.

2. S.H. Patil (1985), *Elements of Modern Physics*, Springer Cham.
3. Puri and Babbar(1998), *Solid State Physics*, MGH Co.

Course Title: Remote Sensing

Course Code: MPY209

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1.Understand the concepts of Photogrammetry and compute the heights of objects
2. Understand the principles of aerial and satellite remote sensing, Able to comprehend the energy interactions with earth surface features, spectral properties of water bodies.
3. Understand the basic concept of GIS and its applications, know different types of data representation in GIS.
4. Understand and Develop models for GIS spatial Analysis and will be able to know what the questions that GIS can answer.

Course Contents

UNIT I **Hours 15**

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 **Hours 15**

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 **Hours 15**

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 of Map Projections-Map Projection Parameters-Commonly used Map Projections – Projected Coordinate Systems.

UNIT IV **Hours 15**

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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:

1. John R. Jensen(2013), *Remote Sensing of the environment- An earth resource perspective,* Pearson Education.
2. Chor Pang Lo (2016), *Concepts & Techniques of GIS*, Prentice Hall Publications.
4. S.Kumar, (2016), *Basics of Remote Sensing and GIS,* Laxmi Publications.

Course Title: Astrophysics
Course Code: MPY210

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Attain the knowledge of evolution, classification, formation of, stars, planets, satellites, and theory of interstellar medium.
2. Get familiar with the structure and population of the Milky Way galaxy, properties of galaxies and its classifications.
3. Learn theoretical and practical aspects of modern observational astronomy.
4. Understand and apply basic physics and computational techniques to solve problems in astrophysics, and interpret the results.

Course Contents

UNIT I **Hours 15**

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, Mass-Luminosity relation; free electron scattering and bound-free scattering, HR diagram. Basic concepts of – gamma rays, X-rays, UV, visible, infra-red, radio waves.

UNIT II **Hours 15**

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 **Hours 15**

Stellar evolution and nucleosynthesis: 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, late stage evolution of stars, red giant phase, white dwarf, supernova (type Ia, Ib/c, II), neutron star, black hole, stellar nucleosynthesis, hydrostatic and explosive nucleosynthesis, s-process, r-process, the galactic chemical evolution.

UNIT IV **Hours 15**

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

SUGGESTED READINGS:
1. H.S. Goldberg and M.D. Scadron (1986), Physics *of stellar evolution and cosmology*, Gordon and Breach publishers.
2. A.E. Roy and D. Clarke (2003), *Astronomy: Principles and Practice*, Adam Hilger Publishers.
3. T. Padmanabhan (2005), *Theoretical Astrophysics (Vol. I, II, III)*, Cambridge University Press.

Course Title: Neutron Physics

Course Code: MPY211

L	T	P	Credits
4	0	0	4

Total Hours: 60

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

1. Comprehend the fundamental properties of the Protons and thermal neutrons.
2. Observe the reactions induced by neutrons, slowing down of neutrons and moderate time.
3. Explain about the neutron chain reactions, spectrometry and their kinematics.
4. Obtain employment in research and development related to reactor physics.

Course Contents

UNIT I **Hours 15**

Thermal Neutrons: Energy distribution of thermal neutrons, Effective cross section of thermal neutron, slowing down of reactor neutrons, Angular and energy distribution, Transport mean free path and scattering cross-section, Average logarithmic energy decrement, slowing down power and moderating ratio, slowing down density, Slowing down time, Resonance escape probability.

UNIT II **Hours 15**

Neutron Chain Reaction: Neutron cycle and multiplication factor neutron leakage and critical size, nuclear reactors and their classification. Neutron Sources: Alpha particle neutron sources, photo neutron sources, Accelerators and nuclear reactors as sources of neutrons.

UNIT III **Hours 15**

Neutron Diffusion: Thermal Neutron diffusion, Neutron diffusion equation, Thermal Diffusion length, Exponential pile, Diffusion length of a fuel – moderator mixture, Fast neutron diffusion and Fermi age equation.

UNIT IV **Hours 15**

Neutron: Production /detection /Properties: Analysis of nuclear spectrometric data, Measurement of nuclear energy levels, spins, parities, moments, internal conversion coefficients. Production of neutron, Detection of neutron production and detection of gamma photons.

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

SUGGESTED READINGS:

1. Liverhant, S.E. (1996), *Elementary Introduction to Nuclear Reactor Physics*, John Wiley & Sons Publishers.
2. Krane K.S. (2005), *Introductory Nuclear Physics*, John Wiley & Sons, New York.

Semester: 3rd

Course Title: Digital Electronics

Course Code: MPY301

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Comprehend the working of Different Semiconductor devices (Construction, Working Principles and V-I characteristics) and their applications.
2. Describe Basic operational amplifier characteristics, OPAMP parameters, applications as inverter, integrator, differentiator etc.
3. Comprehend with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from to others.
4. Formulate the concepts of Microprocessors and applications in the field of electronic and semiconductor devices.

Course Contents

UNIT I **Hours 15**

Semiconductor Devices: Growth of semiconductor crystals, Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors; Effect of temperature and doping on Carrier concentration and their mobility, Qualitative description of current flow at P-N junction, MOSFET Enhancement and depletion mode. Comparison of JFETs and MOSFETs. Thyristor, SCR, TRIAC, DIAC, UJT, Photo-conductive devices, Photo-conductive cell, Photodiode, LCD.

Operational amplifiers: Ideal operational amplifier and its characteristics. Inverting and non-inverting amplifiers. Differential amplifiers. CMMR. Internal circuit of operational amplifier. Difference and Common mode gain, Operational Amplifier as Summing, Scaling and Averaging Amplifiers, Instrumentation amplifier, Integrator and Differentiator. Comparator.

UNIT II **Hours 15**

Number Systems : Binary, octal and hexadecimal number systems. Arithmetic operations: Binary fractions, Negative binary numbers, floating point representation, Binary codes: weighted and non-weighted binary codes, BCD codes, Logic Gates: AND, OR, NOT, OE operations: Boolean identities, DE Morgan's theorem: Simplification of Boolean functions. NAND, NOR gates.

Sequential Circuits: Flip-Flops – RS, JK, T, D; clocked, preset and clear operation, race-around conditions in JK Flip-flops, master-slave JK flip-flops, Shift registers, Asynchronous and Synchronous counters (up, down, up-down, decade), Counter design and applications.

UNIT III **Hours 15**

Digital to analog and analog to digital converters: Binary equivalents of analog signals. Weighted register and binary ladder networks. Digital to analog converter, Performance criteria for digital to analog converters. Resolution and accuracy. Analog to digital converters. Performance criteria for analog to digital converters; counter; up down, Successive approximation.

Semiconductor memory devices: Classification and characteristics of memories, read only memory (ROM organization, PROM, EEPROM), RAM (Bipolar RAM, MOS RAM), Static and Dynamic Random Access Memories, Charged Couple Device Memory, Applications.

UNIT IV **Hours 15**

Microprocessors: Fundamentals of Microprocessors, Buffer Registers, ALU, Timing and control section and their arrangement in 8085 microprocessor.

Instruction classification, addressing modes, timing diagram, Data transfer operations, Arithmetic operations. Logic and Branch operations. Memory 33 interfacing, interfacing I/O devices.

Microcontroller: Overview of the 8051 family and Architecture.

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

SUGGESTED READING:

1. Ryder J.D. (1975), *Electronic Fundamentals and Applications*, Prentice Hall of India, New Delhi.
2. Sze S.M. (1985), *Semiconductor Devices: Physics and Technology*, Wiley Publishers.
3. Malvino A.P. (2014), *Digital Principles and Applications*, Tata McGraw-Hill, New Delhi.

Course Title: Nuclear and Particle Physics

Course Code: MPY302

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Analyze the ideas of basics of nucleus and their energy.
2. Demonstrate the mechanism of particle accelerators and detector technologies.
3. Able to understand the different types of the radioactive decay and kinetics of nuclear reactions.
4. Build a foundation for the students to carry out research in the field of nuclear physics, high energy physics, nuclear astrophysics, nuclear reactions and applied nuclear physics.

Course Contents

UNIT I **Hours 15**

Static properties of nuclei: Nuclear radii and measurements, nuclear binding energy (review), nuclear moments and systematic, wave-mechanical properties of nuclei, hyperfine structure, effect of external magnetic field, Nuclear magnetic resonance. Evidence for saturation of nuclear density and binding energies (review), types of nuclear potential, Ground and excited states of deuteron, dipole and quadrupole moment of deuteron, n-p scattering at low energies, p-p scattering, meson theory of nuclear forces.

UNIT II **Hours 20**

Radioactive decays: Review of barrier penetration of alpha decay & Geiger-Nuttal law. Beta decays, Fermi theory, Kurie plots and comparative half-lives, Allowed and forbidden transitions, Experimental evidence for Parity-violation in beta decay, Electron capture probabilities, Double beta decay, Neutrino, detection of neutrinos, measurement of the neutrino helicity. Multipolarity of gamma transitions, internal conversion process, transition rates, Production of nuclear orientation, angular distribution of gamma rays from oriented nuclei.

UNIT III **Hours 10**

Accelerators: Linear accelerator and Betatron, Cyclotron, Van de Graaff and Pelletron Accelerators, Synchrotrons, Colliding Beam Accelerator. Radiation Detectors: Interaction of radiations with matter (Charged particles and electromagnetic radiations), Gas-filled counters, Scintillation and Semiconductor detectors, Energies and intensity measurements.

UNIT IV **Hours 15**

E**lementary 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.

Fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture, types of interactions - electromagnetic, weak, strong and gravitational, units.

Invariance Principles and Conservation Laws: Invariance in classical mechanics and in quantum mechanics, Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.

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

SUGGESTED READING:

1. Knoll G.F. (2000), *Radiation Detection and Measurement*, John Wiley & Sons.
2. Krane K.S. (2005), *Introductory Nuclear Physics*, John Wiley & Sons, New York.
3. I.S. Hughes (1991), *Elementary Particles*, Cambridge University Press
4. F.E. Close (1979), *Introduction to Quarks and Partons*, Academic Press.

Course Title: Advanced Quantum Mechanics

Course Code: MPY303

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Apply time independent and time dependent perturbation theories to solve different problems.
2. Take up research in frontier areas like quantum information, quantum computation, quantum entanglement, quantum fields and quantum gravity.
3. Demonstrate basic concepts of scattering amplitude, symmetries in scattering and to solve scattering problems, to work with partial wave analysis.
4. Use approximate method in Quantum Mechanics to treat molecules.

Course Contents

UNIT I **Hours 20**

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 **Hours 15**

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 **Hours 15**

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 **Hours 10**

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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READING:

1. Thankappan, V.K. (1996), *Quantum Mechanics*, New Age International Publications, New Delhi, 2. Mathews P.M. and Venkatesh K. (1997), *Quantum Mechanics*, Tata-McGraw Pub., New Delhi.
3. Greiner W. (1994), *Quantum Mechanics*, Springer Verlag Publishers, Germany.
4. Sakurai J.J. (1999), *Modern Quantum Mechanics*, Addison Wesley Pub., USA.

Course Title: Electronics Lab

Course Code: MPY304

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Experimentally understand the working of optoelectronic devices.
2. Hands-on experience on verification of circuit laws and theorems.
3. Learn experimental skills of instrument handling.
4. Apply the basic ideas to create, solve and analyze the problems of interest.

Course Contents

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.

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 READINGS:-

1. C.L. Arora ,(2010), *Practical Physics,* S. Chand &Co.
2. R.S. Sirohi,(2012), *Practical Physics*, , WileyEastern.

Course Title: MATLAB Programming Lab

Course Code: MPY305

L	T	P	Credits
0	0	4	2

Total Hours: 30

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

1. Understand the main features of the developing environment of MATLAB program.
2. Design simple algorithms to solve mathematical problems by using operators and conditional statements.

3. Write simple programs in MATLAB to solve scientific and mathematical problems.
4. Plot various types of curves in MATLAB with proper labeling.

List of Programs (Students will perform any 10 programs)

1. Operating MATLAB desktop.
2. Sum of any finite number of terms.
3. Product of any finite number of terms.
4. Computation of Factorial.
5. Computation of e^x ,sinh(x), cosh(x), cos(x), sin(x) etc.
6. LCM of finite number of positive integers.
7. GCD of finite number of positive integers.
8. Sorting of numbers in ascending order.
9. Sorting of numbers in descending order.
10. Addition and Subtraction, multiplication of vectors.
11. Addition and subtraction of two matrices.
12. Multiplication of two matrices.
13. Plotting of different curves along with styles, width etc.

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

SUGGESTED READINGS:-

1. Gilat, Amos (2004), MATLAB: *An Introduction with Applications* 2nd Edition. John Wiley &Sons..

2. Quarteroni, Alfio; Saleri, Fausto (2006). *Scientific Computing with MATLAB and Octave*. Springer.

3.Ferreira, A.J.M. (2009). *MATLAB Codes for Finite Element Analysis*. Springer.

Course Title: Advanced Statistical Physics

Course Code: MPY306

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Explain how the order parameter is used in describing phase transitions.
2. Discuss the phenomenology of first- and second-order phase transitions with particular reference to the Ising model and liquid-gas transition.

3. Be able to compute expectations of random variables with the Langevin equation.
4. To solve the Langevin and Fokker-Planck equations in simple cases.

Course Contents

UNIT I **Hours 15**

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 **Hours 15**

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 **Hours 15**

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

UNIT IV **Hours 15**

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, ted talks, E team

Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READINGS:

1. Huang K. (2008), *Statistical Mechanics*, John Wiley & Sons Publishers.

2.Patharia R.K. (1996), *Statistical Mechanics*, Butterworth Oxford Publishers

3. Fowler, R. H. (1929). *Statistical mechanics: the theory of the properties of matter in equilibrium,* Cambridge: University Press.

Course Title: Plasma Physics

Course Code: MPY307

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Define plasma state, give examples of different kinds of plasma and explain the 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 Contents

UNIT I **Hours 20**

Basics of Plasmas: Occurrence of plasma in nature, definition of plasma, concept of temperature, 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. Simple applications of plasmas.

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 **Hours 15**

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 **Hours 15**

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 **Hours 10**

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, Case analysis.

SUGGESTED READING:

1. Donald A. Gurnett (2017), *Introduction to Plasma Physics*, Cambridge University Press.
2. S.N.Sen (2020),*Plasma Physics*, Pragati Publications.
3. Basudev Ghosh(2017),*Basic Plasma Physics*,Narosa Publishing House

Course Title: Radiation Physics

Course Code: MPY308

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1.Understand 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. Learn the basics of radiation shielding and its applications.

Course Contents

UNIT I **Hours 15**

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 **Hours 15**

Dosimeters: Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors, simple numerical problems on dose estimation.

UNIT III **Hours 15**

Radiation Effects and Protection: Biological effects of radiation at molecular level, acute and delayed effects, stochastic and non-stochastic effects, 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. The ALARA, ALI and MIRD concepts, single target, multi-target and multi-hit theories, Rad waste and its disposal, simple numerical problems.

UNIT IV **Hours 15**

Radiation Shielding: Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations – The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Practical applications and some simple numerical problems.

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:

1. S.Glasstone and A. Seasonke (2014), *Nuclear Reactor Engineering*, Springer Publications.
2. Frederic Alan Smith(2000),Primer In Applied Radiation Physics,World Scientific Publishers.

Course Title: Reactor Physics

Course Code: MPY309

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Explain basic reactor science.
2. Critically examine reactor types to identify their advantages and disadvantages.
3. Compare the merits of new generation reactors and appraise their technical status.
4. Discuss nuclear accidents and evaluate reactor safety measures.

Course Contents

UNIT I **Hours 15**

Interaction of Neutrons with Matter in Bulk: Thermal neutron diffusion, Transport and diffusion equations, transport mean free path, solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium, extrapolation length and diffusion length-the albedo concept.

UNIT II **Hours 15**

Moderation of Neutron: Mechanics of elastic scattering, energy distribution of thermal neutrons, average logarithmic energy decrement, slowing down power and moderating ratio of a medium, slowing down density, slowing down time, Fast neutron diffusion and Fermi age theory, solution of age equation for a point source of fast neutrons in an infinite medium, slowing down length and Fermi age.

UNIT III **Hours 15**

Theory of Homogeneous Bare Thermal and Heterogeneous Natural Uranium Reactors: Neutron cycle and multiplication factor, four factor formula, neutron leakage, typical calculations of critical size and composition in simple cases, the critical equation, material and geometrical buckling, effect of reflector. Advantages and disadvantages of heterogeneous assemblies, various types of reactors with special reference to Indian reactors and a brief discussion of their design feature.

UNIT IV **Hours 15**

Power Reactors Problem of Reactor Control : Breeding ratio, breeding gain, doubling time, Fast breeder reactors, dual purpose reactors, concept of fusion reactors, Role of delayed neutrons and reactor period, Inhour formula, excess reactivity, temperature effects, fission product poisoning, use of coolants and control rods.

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:

1. E.Lewis (2008),*Fundamentals of Nuclear Reactor Physics,* Academic Press Publishers.

2.W.M.Stacey (2018), *Nuclear Reactor Physics*, Wiley-VCHPublishers

Course Title: Material Science

Course Code: MPY310

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Explain the fundamental principles of nanotechnology and their application to biomedical engineering.
2. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature.
3. Apply and transfer interdisciplinary systems engineering approaches to the field of bio and nanotechnology projects
4. Identify and compare state-of-the-art nanofabrication methods and perform a critical analysis of the research literature

Course Contents

UNIT I **Hours 10**

Introductory concepts: structure of materials, why study properties of materials? Structure of atoms - Quantum states-Atomic bonding in solids-binding energy-interatomic spacing - variation in bonding characteristics - Single crystals – polycrystalline - Non crystalline solids - Imperfection in solids – Vacancies – Interstitials - Geometry of dislocation - Schmid´s law - Surface imperfection - Importance of defects - Microscopic techniques - grain size distribution.

UNIT II **Hours 20**

Solid solutions and alloys - Phase diagrams - Gibbs phase rule - Single component systems – Eutectic phase diagram – lever rule - Study of properties of phase diagrams - Phase transformation - Nucleation kinetics and growth

Band model of semiconductors - carrier concentrations in intrinsic, extrinsic semiconductors – organic semiconductors - Fermi level - variation of conductivity, mobility with temperature – law of mass action - Hall effect - Hall coefficients for intrinsic and extrinsic semiconductors – Hall effect devices. Application of diffusion in sintering, doping of semiconductors and surface hardening of metals.

UNIT III **Hours 15**

Mechanical properties - Stress, Strain, Elastic properties – Deformation–elasticity – hardness - Optical properties - Light interaction with solids - Atomic, electronic interaction, non – radiative transition - refraction, reflection, Absorption, Transmission, Insulators, luminescence.

UNIT IV **Hours 15**

Magnetic properties - Paramagnetism - ferromagnetism - domain theory- magnetic hysteresis, Weiss molecular field theory, Heisenberg's theory - magnetic anisotropy - domain walls - Exchange energy– anti-ferromagnetism.

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:

1. W. D. Callister (2013), *Materials Science and Engineering: An Introduction*, John Wiley & Sons.

2 C. Kittel (2005), *Introduction to Solid State Physics*, Wiley Eastern Ltd.

4. V. Raghavan (2015), *Materials Science and Engineering: A First Course*, Prentice Hall.

Course Title: High Energy Physics

Course Code: MPY311

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Understand that all leptons and quarks have corresponding antiparticles.
2. Appreciate that quarks and antiquarks combine to form baryons, antibaryons and mesons.
3. Write balanced strong interactions, understanding the role of gluons
4. Write balanced weak interactions, understanding the role of W and Z bosons

Course Contents

UNIT I **Hours 20**

Particle kinematics: Classification of elementary particles and fundamental interactions, Properties of elementary particles. Lie algebra, Young diagrams for SU(3) representations, Gell Mann-Nishijima scheme, Baryon and meson multiplets, Charged and neutral pions; Strange particles: Masses and lifetimes, production and decays of strange mesons and baryons. Prediction of omega, Hyperon extension,

Quark model:Hadron spectra and quark content, Search for quarks (Hofstadter et al. experiment, qualitative treatment), Need of color quantum numbers.

UNIT II **Hours 15**

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 III **Hours 10**

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 IV **Hours 15**

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),

Recent developments in high energy physics: 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, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis.

SUGGESTED READING:

1. D.J. Griffiths (2008), *Introduction to Elementary Particles*, Wiley-VCH Publishers.
2. D.H.Perkins, (2000), *Introduction to High Energy Physics,*Cambridge University Press

L	T	P	Credits

Course Title: Electronic Communication Physics

4	0	0	4

Course Code: MPY312

Total Hours 60

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

1. Understand the basic concepts of the analog communication systems.
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. Understand the influence of noise over Analog Modulation schemes through random process and noise theory and applications of Analog communication techniques.

Course Contents

UNIT I **Hours 15**

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.

Radar systems: Basic principles, pulsed radar systems, moving target indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array radars.

UNIT II **Hours 15**

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.

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 III **Hours 15**

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.

Broadband communication systems: Frequency division multiplex (FDM), Time division multiplex TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony.

UNIT IV **Hours 15**

Microwave Radio communications and system gain: Advantages of microwave communication, frequency modulated microwave radio system, microwave radio repeaters, protection switching arrangements, FM microwave radio stations, path characteristics, system gain.

Optical fiber communications: History of optical fibers, type of optical fibers, optical fiber communication system (block diagram), propagation of light through an optical fiber, optical fiber configurations, losses in optical fiber cables, light and optical sources, light detectors.

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:

1. Simon Haykin (2016),*An Introduction to Analog and Digital Communications*, John Wiley Sons Publishers.
2. G. Kennedy and B. Devis (2011), *Electronic communication systems*, Tata McGraw Hill Publishers.
3. W. Tomasi (2008), *Electronic communication systems*, Pearson Education Asia.

Course Title: LASER Physics

Course Code: MPY313

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Describe the principles and design considerations of various (solid state, gas and semiconductor) lasers, modes of their operation and areas of their application.
2. Analyze the origin and different line spectra and different levels of laser.
3. Gain the basic skills of practical work with lasers and optical instruments.
4. Use knowledge in working of optical fiber and of laser spectroscopy.

Course Contents

UNIT I **Hours 15**

Introductory Concepts: Absorption, spontaneous and stimulated emission, the laser idea, Properties of laser light. Interaction of radiation with matter: Summary of black body radiation theory, Rates of absorption and stimulated emission, Allowed and forbidden transitions, Line broadening mechanisms, Transition cross-section, Absorption and gain coefficient, Non-radiative decay, Decay of many atom systems.

UNIT II **Hours 15**

Pumping processes: Optical and electrical pumping, Passive optical resonators: Photon lifetime and cavity Q. Plane parallel resonator; approximate treatment, Fox and Li treatment, confocal resonator, Stability diagram. Laser rate equation: Three level and four level lasers: Optimum output coupling, Laser spiking.

UNIT III **Hours 15**

Types of lasers: Ruby lasers, Nd: YAG laser, He-Ne laser, CO_2laser, N_2 laser, Excimer laser, Dye lasers, Chemical lasers, Semiconductor lasers, Color center and free electron lasers. Nonlinear optics: Harmonic generation, Phase matching, Optical mixing, parametric generation of light, Self-focusing, Multi-quantum photoelectric effect. Two photon process theory and experiment.

UNIT IV **Hours 15**

Laser spectroscopy: Stimulated Raman Effect. Hyper Raman Effect. Coherent anti-stokes Raman spectroscopy. Spin-flip Raman laser, Photo acoustic Raman spectroscopy. Laser Induced Phenomena: Modulation of an electron wave by a light wave, Laser induced collision processes-Pair excitation, Multi-photon ionization, Single atom detection with laser, Laser cooling and trapping of neutral atoms, Applications of Laser.

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 READINGS:

1. Svelte O. (2010), *Principles of Lasers*, Springer Publishers.
2. Thyagarajan, K, (2011), *Laser: Fundamentals and Applications*, Springer Publishers.
3. Karl F. Rank, (2005),*Basics of Laser Physics*, Springer Publishers.

Course Title: General Physics

Course Code: MPY314

L	T	P	Credits
2	0	0	2

Total Hours 30

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

1. Explain physics related phenomenon using basic physics principles and terminology
2. Perform basic calculation/estimations to solve simple physics related problems
3. Make correct judgement/decisions on physics related issues in their daily life based on basic physics principles.
4. Understand the importance of physics in everyday life.

Course Contents

UNIT I **Hours 10**

Transportation : Linear motion, Speed, velocity, acceleration, Force, Newton's laws, circular motion, friction, collision, energy and momentum

Sports: Force, energy, projectile motion, rotation, moment of inertia, angular momentum

UNIT II **Hours 5**

Weather and climate : Energy, heat and temperature, the first law thermodynamics, heat transfer, black body radiation.

UNIT III **Hours 8**

Home Electricity : Electrostatics, electric potential, current, and resistance, ohm's law, electric power, refrigeration, electric safety.

UNIT IV **Hours 7**

Green Energy : Electricity as energy, Electromagnetic Induction, thermal power generation, heat engine, nuclear power, solar power, wind power, biofuels.

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 :

1. Louis A. Bloomfield (2006), *How Things Work- The Physics of Everyday Life*, John Wiley & Sons.

Course Title: Physics for competitive exams

Course Code: MPY315

L	T	P	Credits
2	0	0	2

Total Hours 30

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

1. Demonstrate their knowledge of the basic scientific principles and fundamental concepts and skills of the field.
2. Solve problems utilizing scientific reasoning, quantitative methods, and acquired knowledge and skills.
3. Demonstrate knowledge of the basic physics, and technological advancements.
4. Apply knowledge of linear motion, forces, energy, and circular motion to explain natural physical processes and related technological advances.

Course Contents

UNIT-I **Hours 8**

Introduction to Physics, The Universe: Stars, Sun, Asteroids: In a nutshell, The Solar System and Satellites, S.I. Units of Measurement, Motion and Mechanics, Laws of Motion, Fundamental Forces in nature, rotation and revolution of the earth, Work, Energy & Power, Gravitation.

UNIT –II **Hours 7**

Light and electromagnetic radiations, Refraction of Light , Reflection of light from Spherical Mirrors, Reflection of Light, Refraction of light by Spherical Lenses, Refraction of light through a glass prism, The Human Eye and its defects, Electromagnetism, Sound: Doppler Effect and Echo

UNIT- III **Hours 10**

Electricity & Magnetism, Electric current, resistance of a conductor, Magnetic effect of electric current. Thermal Expansion of Solids, Liquids and Gases, Mechanical Properties of Fluids, Radioactivity ,Nuclear Fission and Fusion, Atomic Theories, Modern physics .

UNIT-IV **Hours 5**

Various Scientific Instruments, First in Space, Important Inventions, recent phenomenon in the news, Nobel Prize winners and their achievements, ISRO, DRDO, Ministry of Science & Technology.

Transaction Mode- Lecture, Demonstration, Project Method, Co-Operative learning, Seminar, Group discussion, Team teaching, Tutorial, Problem solving, E-team teaching, Self-learning.

SUGGESTED READINGS :

1. Louis A. Bloomfield (2006), *How Things Work- The Physics of Everyday Life*, John Wiley & Sons.

Course Title: Disaster Management

Course Code: MPY316

L	T	P	Credits
2	0	0	2

Total Hours 30

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

1. Describe disaster and identify the types of disaster
2. Apply principles of disaster management in daily life.
3. Assess the solution for handling disaster.
4. Understand the factors that causes the disaster.

Course Contents

UNIT I **Hours 8**

Understanding Disasters: Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management Types, Trends,

UNIT II **Hours 7**

Causes, Consequences and Control of Disasters :Geological Disasters; Hydro-Meteorological Disasters, Biological Disasters and Man -made Disasters Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

UNIT III **Hours 10**

Disaster Management in India :Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter- Governmental Agencies .

UNIT-IV **Hours 5**

Applications of Science and Technology for Disaster Management: Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination). Institutions for Disaster Management in India.

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 READINGS:

1. M C Gupta, *Manual on natural disaster management in India,* NIDM, Delhi.

Semester: 4th

Course Title: Experimental Techniques in Physics

Course Code: MPY401

L	T	P	Credits
4	0	0	4

Total Hours 60

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

1. Enhance in depth about thin film preparation and production controlling techniques and the application of thin films in the field of science & Technology.
2. Acquire knowledge about different material analysis techniques and applications.
3. Obtain employment in research and development, in the scientific or engineering industries.
4. Explain about XRD, TEM and other techniques for thin film characterization.

Course Contents

UNIT I **Hours 15**

Thin Film Deposition Technology: Thermal evaporation- general considerations and evaporation methods, Sputtering process glow discharge sputtering, chemical methods-electro deposition and chemical vapor deposition, Scanning Electron Microscopy and Transmission Electron Microscope: Basic concepts, Instrumentation & working, Application.

UNIT II **Hours 15**

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 III **Hours 15**

Counting Statistics & Error Prediction: Error analysis, least square fitting, Chi square test, Normal and Poisson distribution, Statistical errors in nuclear particle counting, propagation of errors, Plotting of graphs.

UNIT IV **Hours 15**

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, Group Discussion, ted talks, E team Teaching, Flipped Teaching, Quiz, Open talk, Case analysis

SUGGESTED READINGS:

1. Cooper W.D. and Helfrick A.D. (1985), *Electronic Instrumentation and Measurement Techniques*, Prentice Hall of India Pvt. Ltd.
2. Herzberg G. (1950), *Molecular Spectra and Molecular Structure*, Van Nostrand Publishers.
3. Dr. PatilShriram B (2017), *Experimental Physics*, Wordit Content Design & Editing Services Pvt Ltd.

Course Title: Research Project Analysis
Course Code: MPY402

L	T	P	Credits
0	0	0	20

Total Hours:60

Guidelines for Dissertation:

The purpose of the dissertation in M.Sc Physics 4thsemester is to introduce research methodology to thestudents. It may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem related to subject, participation in some ongoingresearch activity, analysis of data, etc. The work can be carried out in any thrust areas of subject (Experimental or Theoretical) under the guidance of allotted supervisor of the department. Thestudents must submit their dissertation in the department as per the date announced for thesubmission.

Internal assessment of the dissertation work will be carried out by respective supervisor throughpower point presentation given by candidates during the semester. External assessment of thedissertation work will be carried out by an external examiner (nominated by the Chairperson of theDepartment) through power-point presentation given by candidates. This load (equivalent to 2 hoursper week) will be counted towards the normal teaching load of the teacher.

1. Dissertation will contain a cover page, certificate signed by student and supervisor, table ofcontents, introduction, Objective, Literature review, methodology, results and discussions, conclusion, and references.

- The paper size to be used should be A-4 size.
- The font size should be 12 with Times New Roman.
- The text of the dissertation may be typed in 1.5 (one and a half) space.
- The print out of the dissertation shall be done on both sides of the paper (instead of single sideprinting)
- The total no. of written pages should be between 40 to 60 for dissertation.

2. The candidate shall be required to submit two soft bound copies of dissertation along with a CD inthe department as per the date announced.

3. Dissertation will be evaluated internally by the supervisor allotted to the student during the Semester.

4. The candidate will defend her/his dissertation/project work through presentation before the External examiner at the end of semester and will be awarded marks.

5. In case, a student is not able to score passing marks in the dissertation exam, he/she will have toresubmit her/his dissertation after making all corrections/improvements & this dissertation shall beevaluated as above. The candidate is required to submit the corrected copy of the dissertation in hardbound within two weeks after the viva - voce.

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

ACADEMIC INSTRUCTIONS

Attendance Requirements

A student shall have to attend 75% of the scheduled periods in each course in a semester; otherwise he / she shall not be allowed to appear in that course in the University examination and shall be detained in the course(s). The University may condone attendance shortage in special circumstances (as specified by the Guru Kashi University authorities). A student detained in the course(s) would be allowed to appear in the subsequent university examination(s) only on having completed the attendance in the program, when the program is offered in a regular semester(s) or otherwise as per the rules.

Passing Criteria

The students have to pass both in internal and external examinations.

The minimum passing marks to clear in examination is 40% of the total marks.