Annexure 13.1

Avinashilingam Institute for Home Science and Higher Education for Women

(Deemed to be University under Category A by MHRD, Estd. u/s 3 of UGC Act 1956)
Re-accredited with A++ Grade by NAAC. Recognised by UGC Under Section 12 B
Coimbatore - 641 043, Tamil Nadu, India

Department of Physics
M.Sc. Physics

Programme Outcomes:

The graduates will be able to

1. Apply possessed knowledge in Physics to solve different problems.
2. Analyse various research and scientific problems.
3. Design system relations with appropriate consideration to safety, economy, health and environmental considerations.
4. Solve complex scientific problems by conducting scientific derivations or mathematical simulations.
5. Use modern tools, resources and software.
6. Apply their responsibilities in social and environmental context.
7. Exhibit professional ethics and norms of scientific development.
8. Function individually and in teamwork.
9. Communicate effectively in both verbal and written forms.
10. Manage the work and finance of a research, application projects.

Programme Specific Outcomes:

1. Apply the basic and applied knowledge in the experimental and theoretical fields of Materials Science, Mechanics and Electronics.
2. Execute the General Physics and research oriented experiments with analytical skills for interpretation of results.
3. Select Academic, Research and Industrial careers in Physical Science and allied fields.

Scheme of Instruction and Examination
(For students admitted from 2023 - 2024 and onwards)

PART	Subject Code.	Name of the paper/ Component	Hrs of instructions /week		Scheme of Examination				Credits
			T	P	Duration of exam	CIA	CE	Total	
First Semester									
I	23MPHC01	Mathematical Physics I	5	-	3	40	60	100	5
I	23MPHC02	Classical Mechanics	5	-	3	40	60	100	5
I	23MPHC03	Molecular Spectroscopy	4	-	3	40	60	100	4
I	23MPHC04	Solid State Physics	4	-	3	40	60	100	4
I	23MPHC05	Advanced Electronics	4	-	3	40	60	100	4
I	23MPHC06	Practical I General Physics and Electronics	-	6	6	40	60	100	4
II		C.S.S./Adult Education/Community Engagement and Social Responsibility	2	-	-				
Second Semester									
I	23MPHC07	Quantum Mechanics I	5	-	3	40	60	100	5
I	23MPHC08	Statistical Mechanics	5	-	3	40	60	100	5
I	23MPHC09	Advanced Condensed Matter Physics	4	-	3	40	60	100	4
I	23MPHC10	Mathematical Physics II	4	-	3	40	60	100	4
I	23MPHC11	Practical II General Physics and Electronics	-	5	6	40	60	100	4
I	23MPHC12	Mini Project	1	-	-	100		100	2
I		Inter Disciplinary Course	4	-	3	40	60	100	4
II	23MXCSS1/ 23MXAED1/ 23MXCSR1	C.S.S./Adult Education/Community Engagement and Social Responsibility	2	-					2
II		Professional Certification course							2
Internship during summer vacation (1 month)									

Third Semester									
I	23MPHC13	Electromagnetic Theory and Electrodynamics	5	-	3	40	60	100	5
I	23MPHC14	Nuclear and Particle Physics	5	-	3	40	60	100	5
I	23MPHC15	Quantum Mechanics II	5	-	3	40	60	100	5
I	23MPHC16	Numerical Methods (Open Book Test)	5	-	3	100	-	100	5
I	23MPHC17	Nanomaterials and Fabrication (Self Study Course)	1	-	3	40	60	100	4
I	23MPHC18	Practical III General Physics and Electronics	-	6	6	40	60	100	4
I		Multidisciplinary Course	2	-	3	100	-	100	2
		Library	1						
II	23MPHC19	Internship				100		100	2
Fourth Semester									
I	23MPHC20	Research Project		30	-	100	100	200	8
		TOTAL							**98**

Other Course to be undergone by the students:
MOOC Course: 2 - 4 credits

Minimum credits to earn the degree: 98 + 2 credits
Other courses offered by the Department:

Interdisciplinary Course : **23MPHI01 LASER and its day-to-day Applications**

Multidisciplinary Course : **23MPHM01 Physics and Life**

Professional Certification Course : **23MPHPC1 ARDUINO with Sensor Interfacing**

Mathematical Physics I

Semester: I **Hours of instruction/week:5**
23MPHC01 **Number ofCredits:5**

Course Objectives:

1. To study the Mathematical methods for Physics
2. To understand the applications of Mathematics in Physics
3. To equip with the necessary skills of Mathematical Methods

UNIT- I: Determinant and Matrices

Matrix by Vector – Determinant – Matrices- Rank of a Matrix –Eigen values and Eigenvectors of matrices -Orthogonal matrices –Transpose ,conjugate matrices, Finding Inverse & Adjoint of Matrices - Hermitian Matrices –Unitary Matrices –Diagonalization –Normal Matrices- Cramers rule- Cayley Hamilton theorem **- 15 hrs**

UNIT – II: Vectors and Tensors

Scalars, vectors and tensors in index notation –Del and Laplacian operators – Vector calculus in index notation – Dirac delta function – Representation and properties – Algebra of Cartesian tensors – Outer product –Contraction and quotient theorems – Kronecker & Levi-Civita tensors. **-15 hrs**

UNIT – III: Complex Variables

Elements of analytic function theory - Cauchy-Riemann conditions – Singularities, poles and essential Singularities – Cauchy's integral theorem -Cauchy integral formula – Residue theorem and contour integration - Residue method for real integration – Taylor and Maclaurin expansion – Laurent and Taylor series of complex functions . **-15 hrs**

Unit IV: Probability theory

Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem. **-15 hrs**

UNIT –V: Group theory

Concept of Group, Abelian group, Subgroup -Homomorphism, isomorphism- Reducible and irreducible representations- orthogonal and unitary groups-Continuous and Lie groups. Group representations -The symmetry group D2 and D3 - One-dimensional unitary group SU(1) Orthogonal groups SO(2) and SO(3) -The SU(n) groups. Homogeneous Lorentz group. **-15 hrs**

Total hours: 75

References:

1. G. Arfken& Weber,***Mathematical Methods for Physicists (5 th Edition)***; Academic Press, (2001).
2. Mary L.Boas, **Mathematical methods in the Physical Sciences,** ***(3rd Edition)***; John Wiley& Sons. Inc., (2006).
3. K.F.Riley ,M.P.Hobson&S.J.Bence, ***Mathematical methods for Physics and Engineering, (3rd Edition)***; Cambridge University Press,(2006).
4. SCHAUM'S Outlines,***Mathematics for Physics Students,***(2011).

5. Erwin Kreyszig, ***Advanced Engineering Mathematics (9^th^ Edition);*** John Wiley, (2005).
6. R.K. Jain, S.R.K. Iyengar, ***Advanced Engineering Mathematics(3 rd Edition)***; Narosa, (2007).
7. SatyaPrakash, ***Mathematical Physics***; Sultan Chand & Sons,(2000).
8. B.D.Gupta, ***Mathematical Physics*** ,Vikas Publishing House,(1996)
9. http://nptel.ac.in/courses/115103036/7
10. DipakChatterjee, ***Abstract Algebra(2nd Edition);*** *Prentice Hall of India, New Delhi,* (2007).
11. K.F.Riley, M.P.Hobson, S.J.Bence, ***Mathematical Methods for Physics and Engineering,***Cambridge University PressISBN-13 978-0-II-I6842-0 ebook(EBL), (2006)
12. Tai L.Chow, ***Mathematical Methods for Physicists,*** Cambridge UniversityPress, (2003).

Course Outcomes:

1. Apply matrices for solving Simultaneous equations
2. Handle vector operators and understand tensor analysis
3. Apply complex variables to solve problems with complex functions
4. Understand various methods of Probability theory
5. Learn about group theory

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	-	H	H	-	L	M	L	L	H	-	M
CO 2	H	M	-	H	H	-	L	M	L	L	H	-	-
CO 3	H	H	-	H	H	-	-	M	L	L	H	-	M
CO 4	H	L	-	H	H	-	L	M	L	L	H	-	M
CO 5	H	L	-	H	H	-	-	M	L	L	H	-	L

Classical Mechanics

Semester: I
23MPHC02

Hours of instruction/week:5
Number ofCredits:5

Course Objectives:

1. To understand the concepts of Newtonian, Lagrangian and Hamiltonian formalisms
2. To understand the dynamics of objects moving under central force and gain knowledge on the dynamics of rigid bodies
3. To understand the concept of equilibrium and small oscillation

Unit - I Lagrangian Formulation and Variational Principle

Constraints-Generalized Coordinates-Principle of Virtual Work- D'Alembert's Principle-Lagrange's Equation from D'Alembert's Principle (Non-Conservative forces).

Calculus of variations – Hamilton's Principle – Deduction of Hamilton's Principle from D'Alembert's Principle - Lagrange's Equation from Hamilton's principle – Principle of least action.

-15 hrs

Unit-II Central Force Motion

Reduction to equivalent one body problem – Central Force – Equations of Motion under central force – Differential equation for an orbit – Kepler's Law – Stability and Closure of Orbit – Virial Theorem – Scattering in a Central Force Field.

-15 hrs

Unit-III Hamiltonian Dynamics

Generalized momentum and Cyclic coordinates – First Integrals of Motion- Conservation of Linear momentum and Angular Momentum – Hamilton's Function and Conservation of Energy-Harmonic Oscillator.

Canonical Transformation and Poisson's Brackets – Hamilton-Jacobi (H-J) Equation- Hamilton's Characteristic Function – Harmonic Oscillator in H-J method- Action-angle variables- Kepler's Problem in Action-angle variables.

-15 hrs

Unit-IV Rigid Body Dynamics

Angular Momentum- Kinetic Energy – Inertia Tensor-Principle axes – Euler's Angles-Infinitesimal Rotations –Rate of Change of a vector- Coriolis force- Euler's Equations of Motion-Force free motion of a Symmetrical top.

- 15 hrs

Unit-V Theory of Small Oscillations

Equilibrium and Potential Energy – One Dimensional Oscillator – Two Coupled Oscillator – Normal Co-ordinates and Normal Modes-General Theory of Small Oscillations- Vibrations of a Linear Triatomic Molecule.

-15 hrs

Total hours: 75

References:

1. Herbert Goldstein, ***Classical Mechanics***, Narosa publishing house, NewDelhi, (2006).
2. G.Aruldhas, ***Classical Mechanics***, Prentice-Hall, (2008).
3. J.C.Upadhyaya, ***Classical Mechanics***, Himalaya Publishing House, (2005).
4. N.C.Rana and P.S. Joag, ***Classical Mechanics,*** Tata McGraw Hill, (2015).
5. B. D. Gupta and SatyaPrakash., ***Classical Mechanics,***KedarnathRamnath, (1989).
6. S.L.Gupta, V.Kumar and H.V.Sharma, ***Classical Mechanics,*** Pragathiprakashan, Meerut (2001).
7. G.B.Arfken and H.J. Weber, ***Mathematical Methods for Physicists,***Academic Press, (2006).

Course Outcomes:

1. Formulate equation of motion and describe the dynamics of an object under Newtonian, Lagrangian and Hamiltonian formalisms
2. Identify the presence of central force and to analyze the motion of planetary objects.
3. Explain the conceptual framework of brackets and use these operators to describe the dynamics of harmonic oscillator
4. Discuss the dynamics of a rigid body
5. Distinguish between different types of equilibrium and to apply the concept for small oscillation

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	L	L	L	-	L	L	L	-	H	-	M
CO 2	H	H	L	L	L	-	L	L	L	-	H	-	M
CO 3	H	H	L	L	L	-	L	L	L	-	H	-	M
CO 4	H	H	L	L	L	-	L	L	-	-	H	-	L
CO 5	H	H	L	L	L	-	L	L	L	-	H	-	L

Molecular Spectroscopy

Semester: I
23MPHC03

Hours of Instruction/week: 4
Number of Credits: 4

Course Objectives:

1. To comprehend Rotational Spectroscopy
2. To learn Vibrational Spectroscopy and SERS
3. To understand Electronic Spectroscopy and NMR

Unit-I: Microwave Spectroscopy

Electromagnetic Region and its Spectrum- Interaction of Radiation with rotating molecule- Linear Top- Symmetric Top: Prolate- Oblate- Asymmetric Top- Rigid Rotator- Moment of inertia and reduced mass of diatomic molecules- Successive line separation in Diatomic Molecules- Isotope mass calculation- Intensity of Rotational lines- Non Rigid Rotator- Microwave Spectrometer- Information derived from Rotational spectra.

-12 hrs

Unit-II: IR Spectroscopy

Vibrational energy of a diatomic molecule-Infrared selection rules-Vibration of diatomic molecule - Diatomic vibrating rotator- Vibration of Polyatomic molecules- Normal Vibrations of CO_2 and H_2O molecules- FT IR spectrometer- Applications.

-12 hrs

Unit-III: Raman Spectroscopy and Surface Enhanced Raman Scattering

Classical Theory- Quantum Theory- Rotational Raman spectra of linear molecules- Vibrational Raman Spectra- Mutual Exclusion Principle- Laser Raman Spectrometer- Sample handling Techniques-Applications (SERS). Introduction-Surfaces for SERS study: Cold deposited Metal films-Metals Electrodes-Metal Sol- Enhancement Mechanism: Electromagnetic-Chemical- Surface Selection rules-SERS Microprobe-Applications of SERS.

-12 hrs

Unit-IV: Electronic Spectra

Introduction-vibrational coarse structure Vibrational analysis of band systems-Deslandres table Franck Condon principle – Intensity of vibrational electronic spectra-rotational fine structure of electronic vibration spectra -The Fortrat parabolae

Photoelectron Spectroscopy: Principle – photoelectron spectrometer – orbital energies of atoms – Orbital energies of molecules – binding energy of core electrons

-12 hrs

Unit - V: Nuclear Magnetic Resonance Spectroscopy

Magnetic properties of nuclei -Resonance condition -NMR instrumentation-Bloch equations-Relaxation processes: Spin Lattice relaxation- Spin relaxation - Chemical shifts – NMR Imaging

-12 hrs

Total hours:60

References:

1. G. Aruldhas, ***Molecular Structure and Spectroscopy,(2nd Edition),***Prentice Hall of India Pvt. Ltd., New Delhi, (2008)

2. B.B.Laud, ***Lasers and Non-Linear Optics***, Revised Second Edition, New Age International Publisher,(1985).

3. C. N. Banwell and E. M. McCash, ***Fundamentals of Molecular Spectroscopy-(4th Edition),*** Tata McGrawHill- New Delhi, (2008).
4. D. Pavia, G. M. Lampman, Kriz and J. R. Vyvyan, ***Spectroscopy*** ,Cengage Learning India Pvt. Ltd (2008).
5. B. P. Straughan and S. Walker, ***Spectroscopy Vol. 1 to 3,*** Halsted Press(1978).

Course Outcomes:

1. Analyze the rotational spectra of a molecule
2. Apply IR spectra for diatomic and polyatomic molecules
3. Employ Laser Raman and SERS techniques for molecules
4. Describe the theory of electronic spectra and photoelectronic spectra
5. Deliberate influence of magnetic field on nuclear interactions

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	L	M	M	L	M	M	L	H	-	-
CO 2	H	H	M	L	M	M	L	M	M	L	H	-	-
CO 3	H	H	M	L	M	M	L	M	M	L	H	-	-
CO 4	H	H	M	L	M	M	L	M	M	L	H	-	-
CO 5	H	H	M	L	M	M	L	M	M	L	H	-	-

Solid State Physics

Semester: I
23MPHC04

Hours of Instruction/week: 4
Number of Credits: 4

Course Objectives:

1. To learn Crystal systems and Crystal defects in detail.
2. To study the Crystal vibrations.
3. To understand Diffraction theory and crystal growth.

Unit-I Crystal Structure and Reciprocal lattice:

Three dimensional Bravais lattices- Crystal structure: NaCl –Diamond- Cesium Chloride-Calcium Fluride -The reciprocal lattice concept-Graphical construction-Vector development of reciprocal lattice-Properties of reciprocal lattice-Reciprocal lattice to SC, BCC, FCC lattices-Bragg condition in terms of reciprocal lattices. Ewald's Construction. **-12 hrs**

Unit-II Crystal Defects:

Classification of defects – Point defects-The schottky defect- The Frenkel defect- Colour centers-F- center- other colour centers- Production of colour centers by x-rays or particle irradiation. Dislocation-Slip and plastic deformation -Edge dislocation- Screw dislocation-Stress field around an edge dislocation.

-12hrs

Unit- III Wave Diffraction:

Diffraction of waves in Crystals – Bragg's Law – Scattered wave amplitude – Reciprocal lattice vector – Laue equations – Brillouin Zones- Structure factor and atomic form factor for BCC, FCC.

-12 hrs

Unit IV Crystal Vibrations:

Vibration of monoatomic lattices – Lattices with two atoms per primitive cell – Quantization of lattice vibrations – Phonon momentum – Inelastic scattering of neutrons by phonons - Lattice heat capacity – Einstein model – Density of States in one-dimension and three-dimension – Debye model of the lattice heat capacity –Thermal conductivity – Umklapp process. **-12 hrs**

Unit V: Crystal Growth:

Importance of crystal growth – classification of crystal growth methods -Theories of nucleation – Classical theory – Gibbs Thomson equation for vapor solution and melt – energy of formation of a nucleus –Adsorption at the growth surface-Nucleation – Homogeneous and Heterogeneous nucleation - crystal growth techniques:solution,melt and vapour methods. **-12 hrs**

Total hours: 60

References:

1. C.Kittel, ***Introduction to Solid State Physics***, 8th Edition, Willey Eastern Ltd, New Delhi, (2018).
2. S.O.Pillai, ***Solid State Physics,(7th Edition)*** New Age Int. Publishers, (2014).
3. J. C. Brice, ***Crystal Growth processes***, Halsted press, John Wiley & sons, New York, (1986).
4. Rojer J. Elliot and Alan F.Gibson, ***An Introduction to Solid State Physics and its Applications***, Macmillon Publishers, (1974).
5. Mohammed Abdul Wahab, ***Solid State Physics: Structure and Properties of Materials***, Alpha Science International, (2005).
6. Ashcroft, ***Solid State Physics***,Cengage learning India Pvt. Ltd., New Delhi, (2009).
7. Rajnikant, ***Applied Solid State Physics***, Wiley India Pvt. Ltd.,New Delhi, (2011).

Course Outcomes:

1. Explain crystal structure and reciprocal lattice concepts.
2. Distinguish the types of crystal defects and dislocation
3. Analyze cubic structure in view of diffraction theory and Brillouin zones.
4. Comprehend lattice vibration, Specific heat capacity based on Einstein & Debye model.
5. Describe crystal growth principles and growth methods.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	L	L	H	M	L	L	L	M	M	H	M	M
CO 2	M	M	M	H	M	M	L	L	M	M	H	L	M
CO 3	L	M	M	H	M	L	L	L	M	M	H	M	M
CO 4	M	M	M	H	M	L	L	L	M	M	H	L	M
CO 5	L	M	H	H	M	M	L	L	M	M	H	M	M

Advanced Electronics

Semester: I
23MPHC05 **Hours of Instruction/week: 4**
Number of Credits: 4

Course Objectives:

1. To acquire knowledge of operational amplifier and its applications
2. To understand code conversion and different kinds of modulation techniques used in communication process.
3. To learn about the differences between microprocessor and microcontroller and it's basic instructions and programming.

Unit- I Op - Amps and Linear Integrated Circuits – I:

Differential amplifiers – Operational amplifiers: Characteristics - frequency response of an Op - Amp. DC and AC Amplifiers, Differential Input and Differential Output Amplifier, Voltage-to-Current Converter, Current-to-Voltage Converter. Active filters: Low pass, band pass filter, all pass filters.

- 12 hrs

Unit- II Op – Amps and Linear Integrated Circuits – II:

Digital To Analog Conversion: R-2R Ladder Type D/A, Weighted Resistor Type D/A. Analog To Digital Conversion: Counter Type A/D Converter, Tracking Type A/D Converter, Flash-Type A/D Converter, Dual Slope Type A/D Converter, Successive Approximation Type A/D converter.

Oscillators: frequency stability, Phase Shift Oscillator, Wien bridge Oscillator, Square Wave Generator.

- 12 hrs

Unit- III Registers and counters:

Registers: Serial in-Serial out, Serial in-Parallel out, Parallel in-Serial out, Parallel in-parallel out-shift registers. Counters: binary and decade counters - ring counters, ripple and synchronous type- Up-down counters

- 12 hrs

Unit- IV Digital Modulation:

Introduction- Codes- Analog to Digital Conversion- Pulse Amplitude modulation –Time division Multiplexing- Pulse width Modulation -Pulse Position modulation, frequency shift keying- FSK Demodulation. Frequency division multiplexing- Decoding of the FDM signals - Pulse code modulation- Delta Modulation.

-12 hrs

Unit- V Microprocessor and Microcontroller:

Microprocessor: Architecture and its operations, instruction set and Data format, Input and Output (I/O) Devices. Simple programs: Addition, Subtraction, Multiplication, Division with 8 bit numbers.

Microcontroller: Architecture and its operations of Intel 8051 microcontroller – 8051 MC Hardware –PIN diagram – ports and circuits – external memory – counters and timers. Instruction types: arithmetic, logical, data transfer, Boolean and program branching instructions– simple programs.

-12 hrs

Total Hours: 60

References:

1. John D.Ryder, ***Electronic fundamentals and applications –Integrated and discrete systems***, fifth edition, Prentice Hall of India private limited, New Delhi, (2003).
2. Ramakant A. Gayakward, ***Operational Amplifier and Linear Integrated Circuits***, Prentice Hall of India, (2015).
3. Albert Paul Malvino& Donald P.Leach, ***Digital Principles and applications***, fourth edition, McGraw-Hill Publishing, New Delhi, (2000).
4. Robert J. Schoenbeck, ***Electronic Communications***, Universal book stall, New Delhi, (2000).
5. Kenneth J.Ayala, ***The 8051 microcontroller, architecture, programming and application***, Penram International Publishers, Mumbai, (2003).
6. I. Scott MacKenzie, Raphael C.-W. Phan, ***The 8051 Microcontroller, (4th edition)***, PearsonEducation, (2008).
7. George Kennedy & Davis Bernard,***Electronic communication systems***, ***(4th Edition)***, Tata McGraw –Hill InternationalPublishers, (1999).
8. William H. Gothman, ***Digital Principles and applications***, ***(2nd Edition)***, Prentice Hall of India, (2001).
9. John O Malley, ***Schaum's Outline of Basic Circuit Analysis***, ***(2nd Edition)***, McGraw Hill, (1992).

Course Outcomes:

1. Distinguish various operations of Operational amplifier.
2. Analyze the applications of Op - Amp. as A/D and D/A converters and oscillators
3. Construct the counters and shift registers and their applications.
4. Analyze different types of digital modulation techniques and to measure the band width for the corresponding modulation techniques.
5. Execute basic programmes using microprocessor and microcontroller.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	L	M	H	H	L	M	M	L	H	H	H
CO 2	H	H	L	M	H	H	L	M	M	L	H	H	H
CO 3	H	H	L	M	H	H	L	M	M	L	H	H	H
CO 4	H	H	L	M	H	H	L	M	M	L	H	H	H
CO 5	H	H	L	M	H	H	L	M	M	L	H	H	L

Practical I General Physics and Electronics

Semester: I
23MPHC06

Hours of Instruction/week: 6
Number of Credits: 4

Course Objectives:

1. To understand propagation of laser beam in optical fibers
2. To demonstrate linear applications of operational amplifier.
3. To study about the travelling of optical and ultrasound waves through medium

1. Ultrasonic interferometer- velocity in liquids.
2. Abbe refractometer- refractive index.
3. Characteristics of light emitting diode and determination of Planck's Constant.
4. Study of total internal reflection in solids and critical angle determination.
5. Determination of numerical aperture in optical fiber
6. Determination of bending losses in multi-mode fiber
7. Measurement of laser beam divergence.
8. Four bit binary Adder, Subtractor and BCD adder.
9. Modulus Counters using IC 7490.
10. Frequency Counter to count upto any two digits.
11. Analog circuit to solve two simultaneous equations.
12. Operational Amplifier- Integrator and Differentiator.
13. Operation Amplifier-differential amplifier.
14. Operation Amplifier- Current to Voltage converter/ Voltage to Current converter
15. Determination of wavelength of He- Ne laser.
16. Determination of Crystal Structure for the given diffractogram.

Total hours: 90

Course Outcomes:

1. Analyze the properties of optical fiber
2. Construct the circuits to perform mathematical operations using operational amplifier and other ICs
3. Distinguish the behavior of ultrasound in various liquids
4. Verify the crystallinity
5. Determine the refractive index of liquids

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	H	M	L	M	M	-	L	H	-
CO 2	H	H	H	H	H	M	L	M	M	-	L	H	-
CO 3	H	H	H	H	H	M	L	M	M	-	L	H	-
CO 4	H	H	H	H	H	M	L	M	M	-	L	H	-
CO 5	H	H	H	H	H	M	L	M	M	-	L	H	-

Quantum Mechanics I

Semester: II
23MPHC07

Hours of Instruction/week: 5
Number of Credits: 5

Course Objectives:

1. To understand the basic principles and concepts in Quantum Mechanics
2. To acquire knowledge on matrix and operator formulation of quantum mechanics
3. To learn the general formalism of orbital, spin angular momentum and Clebsch- Gordan Coefficient

Unit-I Evolution of Quantum Theory:

Wave particle duality – De-Broglie Hypothesis- De-Broglie wave- Heisenberg Uncertainty principle – Superposition principle and construction of wave packet – Motion of a wave packet and Schrödinger equation- Probabilistic interpretation of and its normalization – stationary state solutions of the Schrödinger equation – probability current density – expectation values of dynamical variables - Ehrenfest theorem- Correspondence principle - Exact statement and proof of uncertainty principle for wave packet.

-15 hrs

Unit-II Operators in Quantum Mechanics:

Operator- Linear operator – Algebra of linear operators - Eigen function and eigen value of an operator-orthonormal set of eigen functions-Complete set of eigen function- completeness relation- Hermitian operator- Properties of Hermitian operator- Adjoint of an operator – Simultaneous measurability and commutators- Uncertainty relation operators – Fundamental commutation relation – connection between commutator brackets and Poisson brackets- equation of motion for operator - Unitary operator.

- 17 hrs

Unit-III Matrix Formulation of Quantum Mechanics:

Linear vector space-Direct product and direct sum of vector spaces – Linear dependence of vectors – dimensionality of a vector space- orthonormal vectors- Schmidt's orthonormalization method - Hilbert space-Dirac's bra and ket notations- Dual vectors – Matrics representation of linear operators- Algebra and properties of matrices – Eigen value and eigen vectors of the matrix of an operator – Change of basis functions – Unitary and similarity transformation- Properties of unitary transformation- Concept of continuous matrices- Various quantum mechanical pictures- matrix theory of harmonic oscillator.

-17hrs

Unit-IV Applications of Schrödinger Equation:

Time independent Schrödinger equation- time dependent Schrödinger equation- Schrödinger equation for a free particle- Free particle solution - Particle in a box - Potential well of finite depth (one dimension) – Square potential step barrier- Rectangular potential barrier - One dimensional linear harmonic oscillator - The Hydrogen atom – Degeneracy.

- 13hrs

Unit-V Orbital and spin Angular Momentum:

Orbital angular Momentum- Commutation relations for orbital angular momentum- Eigen value problem for L^2- Eigen value problem for Lx, Ly and Lz – Matrix elements of orbital angular momentum operators – spin angular momentum – generalized angular momentum.
Eigen values of J^2 and J_Z – Addition of angular momenta: Recursion relations for Clebsch-Gordan Coefficients – Construction of CG coefficients – Identical particles with spin – Rotation operator and angular momenta.

-13hrs

Total hours: 75

References:

1. SatyaPrakash, ***Advanced Quantum Mechanics***, Kedarnath Ram NathCo.,Meerut.(all units), (2001).
2. P.M. Mathews and Venkatesan, ***A textbook of Quantum Mechanics***, 27th reprint Tata McGraw Hill Publishing company Ltd., New Delhi, (2002).
3. S. L. Gupta and I. D. Gupta, ***Advanced Quantum theory & Fields***,S.Chand and Company Ltd., New Delhi, (1982).
4. G. Aruldhas, ***Molecular Structure and spectroscopy***,Asoke K. Ghosh, Prentice Hall of India Pvt., Ltd., New Delhi-110001.(all units), (2004).
5. Leonard I. Schiff ,***Quantum Mechanics***, McGraw-Hill Book Company, (1968).
6. V. Devanathan, ***Quantum Mechanics***, Narosa Publishing House, New Delhi, (2005).
7. Ghatak and Loganthan,***Quantum Mechanics- Theory and Applications***,(4th **edition)**,Rajiv Beri for Macmillan India Limited, New Delhi, (1999).
8. R.K.Prasad,***Quantum Chemistry***,H.S.Poplai for Wiley Eastern Ltd., New Delhi, (1992).
9. Eugen Merzbacher, ***Quantum Mechanics, (Third Edition)***,John Wiley& Sons, Inc. (2016).

Course Outcomes:

1. Explain the evolution of quantum theory
2. Enumerate properties of operators in quantum mechanics.
3. Describe about linear vector spaces, Hilbert space, concepts of basis and operators
4. Solve Schrödinger equations for various potentials and apply to hydrogen atom
5. Analyze orbital and spin angular momentum matrices and calculate Clebsh-Gordan Coefficient

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	-	H	H	-	L	L	L	-	H	-	M
CO 2	H	H	-	H	H	-	L	L	L	-	H	-	M
CO 3	H	H	-	H	H	-	L	L	L	-	H	-	M
CO 4	H	H	-	H	H	-	L	L	L	-	H	-	M
CO 5	H	H	-	H	H	-	L	L	L	-	H	-	M

Statistical Mechanics

Semester: II
23MPHC08

Hours of Instruction/week: 5
Number of Credits: 5

Course Objectives:

1. To understand the connection between statistical concepts and thermodynamics
2. To acquire knowledge on different ensembles and of classical and quantum gases, other condensed matter systems in equilibrium
3. To distinguish between classical and quantum distributions and understand phase transitions

Unit – I Statistical Basis of thermodynamics:
Laws of thermodynamics, entropy, Thermodynamic potentials - The connection of Free energy with thermodynamic quantities -The macroscopic and microscopic states- Contact between statistics and Thermodynamics: physical significance of the number Ω (N,V,E) – The classical ideal gas – The entropy of mixing and the Gibb's paradox – enumeration of microstates **-15 hrs**

Unit – II Classical ensemble theory I:
Phase space, microstates and macrostates; Liouville's equation, Postulates of statistical mechanics, Microcanonical ensemble, Boltzmann relation for entropy, Definition of temperature, derivation of the laws of thermodynamics for macroscopic systems, Sackur-Tetrode equation **-15 hrs**

Unit – III Classical ensemble theory II:
Canonical ensemble; partition function;
Helmholtz free energy, Grand-canonical ensemble: equilibrium between a system and a particle-energy reservoir – A system in grand canonical ensemble, Physical significance of statistical quantities. **-15 hrs**

Unit – IV Quantum statistical mechanics:
Indistinguishable particles in quantum mechanics. Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. Density operator, Quantum Liouville equation. Pure and mixed states. **-15 hrs**

Unit – V Theory of phase transitions:
Interacting spin systems. The Ising model. Exact solution of Ising model in 1-dimension, mean-field solution in higher dimensions. Paramagnetic and ferromagnetic phases. Critical exponents. Order parameter, Landau theory, Universality. Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams for pure systems. **-15 hrs**

Total hours: 75

References:

1. Mehran Kardar, ***Statistical Physics of Particles***, Cambridge University Press, (2007).
2. R. K. Pathria, Paul D. Beale, ***Statistical Mechanics,*** Elsevier Third Edition, (2017).
3. Palash B. Pal, ***An Introductory Course of Statistical Mechanics***, Narosa Publishing House New Delhi, (2008).
4. Kerson Huang. K, ***Statistical Mechanics***, John Wiley and Sons, (2008).
5. Avijit Lahiri, ***Statistical Mechanics An Elementary Outline*** - CRC Press, Taylor and Francis, (2009).
6. R. K. Sinha, J. Ashok, ***Statistical Mechanics,*** Prentice Hall of India, New Delhi, (2005)
7. F. Reif, ***Fundamentals of Statistical and Thermal Physics***, McGraw Hill Inc., (1965).
8. L. D. Landau and E. M. Lifshitz, ***Statistical Physics***, Course on Theoretical Physics, vol. 5, 9, Elsevier, (1980).
9. B. K. Agarwal, Melvin Eisner, ***Statistical Mechanics***, New Age International Publishers, (2018).

Course Outcomes:

1. Establish the connection between statistics and thermodynamics
2. Distinguish between three types of ensembles and derive their partition functions to explain the behaviour of classical and quantum systems
3. Analyze the classical and quantum statistics
4. Compare the statistical behavior of ideal Bose gas and Fermi gas
5. Discuss on heat capacities for gas, solids and understand phase transitions

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	L	M	L	-	-	L	L	-	H	-	M
CO 2	H	H	L	M	L	-	-	L	L	-	H	-	M
CO 3	H	H	L	M	L	-	-	L	L	-	H	-	M
CO 4	M	H	L	M	L	-	-	L	L	-	H	-	M
CO 5	H	H	L	M	L	-	-	L	L	-	H	-	M

Advanced Condensed Matter Physics

Semester: II
23MPHC09

Hours of Instruction/week: 4
Number of Credits: 4

Course Objectives:

1. To learn free electron theory
2. To understand Dielectrics, Superconductors
3. To learn about Magnetism

Unit-I Free electron theory:

Free electron gas- Ohm's law- Electrical conductivity and Thermal conductivity of metals - Free electron gas in one dimension and three dimension –Fermi-Dirac Statistics and Fermi- Dirac distribution – free electron model and origin of band gap. **-10 hrs**

Unit- II Semiconductor Theory:

Band Structure – Fermi Level- Carrier concentration- Density of states –Temperature and Field effects - Effective Mass - Intrinsic and Extrinsic semiconductor - Semiconductor states Continuity Equation- HALL effect- Determination of HALL coefficient- mobility- carrier concentration **-10 hrs**

Unit-III Dielectrics, Ferroelectrics, Piezoelectric and Superconductivity:

Macroscopic electric field – Local electric field at an atom – Clausius-Mossotti equation – Polarization catastrophe - Piezoelectric - Ohmic and Schottky Contacts Occurrence of Superconductivity – Meissner effect – London equation –Coherence length – BCS theory – Flux quantization –Type I and Type II Superconductors –Josephson superconductor tunneling– DC and AC Josephson effect.

-12 hrs

Unit- IV Diamagnetism and Paramagnetism:

Langevin classical theory of Diamagnetism and paramagnetism – Curie Temperature- Weiss theory -Quantum theory of paramagnetism– Demagnetization of a paramagnetic salt **-12 hrs**

Unit-V Ferro magnetism, and Antiferromagnetism:

Ferromagnetism-classical theory of Ferromagnetism Hard and Soft Magnetic materials- Magneto-optical effect Temperature dependence of Spontaneous magnetization - Ferromagnetic Domains-Anisotropic energy- Anti Ferromagnetism- Molecular field theory of Antiferromagnetism - Antiferromagnetic susceptibility above and below the Neel Temperature. **-16 hrs**

Total hours:60

References:

1. C.Kittel, ***Introduction to Solid State Physics, (8th Edition),*** Willey Eastern Ltd, New Delhi, (2018).
2. S.O.Pillai, ***Solid State Physics, (7th Edition),*** New Age Int. Publishers, (2014).
3. Mohammed Abdul Wahab, ***Solid State Physics: Structure and Properties of Materials***, Alpha Science International, (2005)
4. M.P.Marder, ***Advanced Condensed Matter Physics***, John Wiley & Sons (2000).

Course Outcomes:

1. Analyse free electron theory.
2. Distinguish conductors and semiconductors on the basis of Band theory.
3. Explain the effect of macroscopic electric field on dielectric material and learn about superconductivity
4. Describe about Dia and Para magnetism in detail.
5. Discuss Ferro and Antiferro magnetism in detail.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	M	H	M	-	M	M	M	H	-	H
CO 2	H	H	M	M	H	M	M	M	M	M	H	-	H
CO 3	H	H	M	M	H	M	M	M	M	M	H	-	H
CO 4	H	H	M	M	H	M	M	M	M	M	H	-	H
CO 5	H	H	M	M	H	M	M	M	M	M	H	-	H

Mathematical Physics II

Semester: II
23MPHC10

Hours of Instruction/week:4
Number of Credits:4

Course Objectives:

1. To study the methods of solving differential equation and apply for the Physics problem
2. To equip with ability to solve problems using differential and integral special functions
3. To develop mathematical modeling skill using several mathematical methods for Physics problem

UNIT – I Ordinary Differential Equations:

First order ODE's – Separable ODE's – Orthogonal trajectories –Physical modeling– Second order linear ODE's–Differential operators–Homogeneous and inhomogeneous differential equations –Series solution of ODE's– Frobenius method– Liouvllie theorem-Strum-Liouvllie problem-Orthogonal Eigen function expansions. **-12 hrs**

UNIT – II Partial Differential Equations:

Introduction to partial differential equations –Green's function-curvilinear coordinates – Cylindrical polar and spherical polar systems– Divergence,Curl and Grad in polar and Cartesian systems – Solution by analytical methods–Solution of (i) Laplace,(ii) Poisson,(iii) Helmholtz wave and iv) diffusion equations in Cartesian and polar coordinate systems. **- 12 hrs**

UNIT – III Laplace Transforms:

Laplace transforms – Inverse transforms –Linearity and Shifting theorems –Laplace transform of derivative of a function –Laplace transform integral of a function – Unit step function- t-shifting –Short impulses –Dirac delta function – Convolution – Integral equations –Application to solve differential equations. **-12 hrs**

UNIT – IV: Fourier Transforms:

Introduction to Fourier analysis – Half range Fourier series –Harmonic analysis and applications – Forced oscillations –Finite and infinite Fourier transforms– Fourier sine and cosine transforms –Complex Fourier transforms –Fourier expansion and inversion. **-12 hrs**

UNIT–V Special Functions:

Beta, Gamma, Delta and Error functions–Bessel, Hermite, Legendre, Associated Legendre and Laguerre functions–Recurrence relations for $J_n(x)$ and $P_n(x)$. **-12 hrs**

Total hours:60

References:

1. G. Arfken & Weber, ***Mathematical Methods for Physicists, (5th Edition)***, Academic Press, (2001).
2. Mary L.Boas, ***Mathematical methods in the Physical Sciences, (3rd Edition),*** John Wiley& Sons. Inc., (2006).
3. K.F.Riley,M.P.Hobson&S.J.Bence, ***Mathematical methods for Physics and Engineering, (3rd Edition)***; Cambridge University Press,(2006).
4. SCHAUM'S Outlines, ***Mathematics for Physics Students,*** (2011).
5. Erwin Kreyszig, ***Advanced Engineering Mathematics, (9thEdition),*** John Wiley, (2005).
6. R.K. Jain, S.R.K. Iyengar, ***Advanced Engineering Mathematics, (3rdEdition)***, Narosa, (2007).

Course Outcomes:

1. Solve first order, second order homogeneous and non-homogeneous equations
2. Deliver mathematical modeling for Physics problems involving partial differential equations
3. Solve differential equations using Laplace transforms
4. Arrive at a solution for partial differential equation employing Fourier transform
5. Apply special functions in solving integral functions

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	H	L	L	L	L	-	H	-	H
CO 2	H	H	M	H	H	L	L	L	L	-	H	-	H
CO 3	H	H	M	H	H	L	L	L	L	-	H	-	H
CO 4	H	H	M	H	H	L	L	L	L	-	H	-	H
CO 5	H	H	M	H	H	L	L	L	L	-	H	-	H

Practical II General Physics and Electronics

Semester: II **Hours of Instruction/week: 5**
23MPHC11 **Number of Credits: 4**

Course Objectives:

1. To understand the temperature dependence of viscosity of highly viscous liquid and dielectric constant of a piezoelectric material
2. To measure the thermal conductivity of a good conductor and analyze the thermal performance of solar cooker
3. To perform basic arithmetic operations using microcontroller and to operate simple embedded systems using microprocessor

1. Determination of kinematic viscosity – Redwood Viscometer
2. Thermal conductivity of Copper rod – Searle's Apparatus
3. Solar Box Cooker – Figure of Merit
4. Zeeman Effect
5. Millikan's oil drop method – e/m
6. Michelson Interferometer
7. Dielectric constant of solids – Curie temperature method
8. Free running Frequency of a Phase Locked Loop
9. Voltage Controlled Oscillator using 555 Timer
10. Design and study of Multiplexer and Demultiplexer
11. Design and study of Encoder and Decoder
12. Microprocessor Based Traffic Light Controller
13. Microcontroller 8051 -16 bit addition, 8 bit subtraction, 8 bit multiplication
14. Microcontroller 8051 -1s complement, 2s complement
15. Microcontroller 8051 – Hex to Decimal conversion, Decimal to Hex conversion

Total hours: 75

Course Outcomes:

1. Identify thermal conductors/ insulators based on thermal conductivity and discuss the thermal dependence of dielectric solid.
2. Design a basic solar cooker and to analyze its performance
3. Execute progammes using microcontroller/microprocessor
4. Demonstrate Zeeman effect/Millikan's oil drop experiment/Michelson interferometer
5. Design circuits like encoder/decoder, multiplexer/demultiplexer and voltage controlled oscillator/phase locked loops

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	M	H	M	L	-	L	M	L	-	H	H	-
CO 2	H	M	H	M	L	-	L	M	L	-	H	H	-
CO 3	H	M	H	M	L	-	L	M	L	-	H	H	-
CO 4	H	M	H	M	L	-	L	M	L	-	H	H	-
CO 5	H	M	H	M	L	-	L	M	L	-	H	H	-

Electromagnetic Theory and Electrodynamics

Semester: III
23MPHC13

Hours of Instruction/week: 5
Number of Credits: 5

Course Objectives:

1. To understand the concepts in electric and magnetic field interactions
2. To gain knowledge on Maxwell's equations and Electromagnetic boundary conditions.
3. To learn about electrodynamics

Unit-I Electro Statics :

Electric field, Gauss Law – Scalar potential – Multipole expansion of electric fields –Dirac Delta function – Poisson's equation – Laplace's equation – Green's theorem –Uniqueness theorem – Formal solution of electrostatic boundary value problems with Green function – electrostatic potential energy and energy density.

Electrostatics in matter- Polarization and electric displacement vector- Electric field at the boundary of an interface- Clausius - Mossotti equation **-15 hrs**

Unit-II Magneto Statics :

Biot and Savart law – Differential equations of magnetostatics and Ampere's law – The magnetic field of distant circuit – Magnetic moment – The magnetic scalar potential – magnetic vector potential-magnetic dipole in a uniform field - magnetization and magnetostriction effect– Magnetic intensity, susceptibility and permeability – Hysteresis and magnetic circuit **-15 hrs**

Unit-III Time Varying Fields :

Electromagnetic induction – Faraday's law – Maxwell's equations – Displacement current – Vector and Scalar potentials – Gauge transformation – Lorentz gauge – Coulomb's gauge – Gauge invariance – Poynting's theorem. **- 15 hrs**

Unit-IV Plane Electromagnetic Waves :

Plane wave in a non-conducting medium – Boundary conditions – Reflection and refraction of EM waves at a plane interface between dielectrics – Polarization by reflection and total internal reflection - Waves in a conducting or dissipative medium. **-15 hrs**

Unit-V Electrodynamics:

Thomson cross section – Lienard –Wiechert Potentials – The field of a uniformly moving point charge - Radiation from an oscillating dipole – Radiation from a half wave antenna - Radiation damping **-15 hrs**

Total hours: 75

References:

1. John R. Reitz, Fredrick J. Milford & Robert W. Christy, ***Foundations of Electro Magnetic Theory,*** Pearson Education Inc, Addison Wesley, ***(4th Edition)***, (2009).
2. B. B. Laud, ***Electromagnetics***, New Age International (P) Limited Publishers, ***(2ndEdition),*** (1987) Reprint (2005).
3. J. D. Jackson, ***Classical Electrodynamics***, John Wiley and Sons Pte Ltd, (1999).
4. I S Grant, W R Phillips, ***Electromagnetism***,John Wiley & Sons Ltd, Reprinted March (2011).
5. K.K. Chopra,G.C. Agrawal, ***Electromagnetic theory,*** K Nath& Co, (2000).
6. David J. Griffiths, ***Introduction to Electrodynamics***, Prentice Hall,(1999).

Course Outcomes:

1. Describe various concepts of electrostatics and the importance of Laplace and Poisson's equations in electrostatics
2. Apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.
3. Explain effects involved in magnetostatics and understand role of differential equations in magnetostatics
4. Describe the propagation of electromagnetic induction in time varying field.
5. Discuss about plane electromagnetic waves and its propagation.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	-	H	H	M	-	M	-	L	H	-	H
CO 2	H	H	-	H	H	M	-	M	-	L	H	-	H
CO 3	H	H	-	H	H	M	-	M	-	L	H	-	H
CO 4	H	H	-	H	H	M	-	M	-	L	H	-	H
CO 5	H	H	-	H	H	M	-	M	-	L	H	-	H

Nuclear and Particle Physics

Semester: III

23MPHC14

Hours of Instruction/week: 5

Number of Credits: 5

Course Objectives:

1. To gain knowledge on semi-empirical mass formula, shell model and their applications
2. To understand properties of nuclear forces, types of nuclear reactions, Q-value and cross section
3. To learn about different nuclear detectors and gain knowledge on elementary particles, classification, quantum numbers and their conservation.

Unit-I Nuclear properties and structure::

General properties of nucleus- mass defect, binding energy. Weizsacker's semi empirical mass formula- applications of semi-empirical mass formula to alpha decay and mass parabola: stability of nuclei against β-decay. Magic numbers- shell model- single particle states in nuclei for harmonic oscillator potential-spin-orbit interaction- applications of shell model to find nuclear spin, nuclear magnetic moment. **-15hrs**

Unit-II Nuclear forces:

Ground state of the deuteron- binding energy- spin and parity- nucleon-nucleon scattering – p-p and n-n interactions - general properties of nuclear forces: Spin dependence, charge independence and charge symmetry of nuclear forces- Meson theory of nuclear forces. **-15hrs**

Unit- III Nuclear decay and reactions :

Gamow theory of alpha decay and theory of beta decay – Kurie plot and non-conservation of parity in beta decay - gamma decay – multipole moments and selection rules.

Types of Nuclear reactions and conservation laws – energetic of nuclear reaction-reaction cross section, compound nuclear reaction -direct reactions. **-15 hrs**

Unit-IV Nuclear fission and detectors:

Nuclear fission: Energy release in fission- nature of fission fragments- energy distribution in the fission fragments.

Detecting nuclear radiations: ionization chamber - scintillation detectors-semiconductor detectors- Energy measurements – Coincidence measurements and time resolution - Measurement of nuclear life-times. **-15 hrs**

Unit-V Elementary particles:

Classification of elementary particles and their quantum numbers (charge, spin, lepton number, baryon number, parity, angular momentum and strangeness) - Types of interaction strong, weak, electromagnetic and gravitational – Conservation laws- CPT theorem. Symmetry classification of elementary particles- unitary symmetry-SU(3) symmetry-Quark model - Gell- Mann-Okubo mass formula. **-15hrs**

Total Hours: 75

References:

1. Kenneth S. Krane, ***Introductory Nuclear Physics***, Wiley India Pvt. Ltd., (2008).
2. S. N. Ghoshal, ***Nuclear Physics***, S.Chand & company,(2019).
3. John M. Blatt, Victor F. Weisskopf, ***Theoretical Nuclear Physics***, Springer-Verlag New York, (1979).
4. V. Devanathan, ***Nuclear Physics,***Narosa Publications, New Delhi, (2013).
5. D. C. Tayal, ***Nuclear Physics***, Himalaya Publishing House, (2011).
6. M. L. Pandya and R. P. S. Yadav, ***Nuclear physics,***KedarNath Ram Nath, Meerut, (2017).
7. JagdishVarma, R. C. Bhandari, D. R. S. Somayajalu, ***Fundamentals of Nuclear Physics,*** CBS Publishers and distributors- New Delhi, (2005).
8. S. B. Patel, ***Nuclear Physics- An introduction***, New Age International Pvt. Ltd., New Delhi, (2002).

Course Outcomes:

1. Calculate binding energy, describe the applications of semi-empirical mass formula and recognize the importance of spin-orbit interaction through shell model
2. Analyze properties of deuteron and describe the properties of nuclear forces and different interactions such as pp, np, nn
3. Calculate the penetration probability using Gamow theory, understand beta and gamma decay and understand about nuclear reactions
4. Compare different principles used in nuclear detectors and discuss different techniques to measure nuclear half-lives and understand nuclear fission
5. Analyze whether a reaction involving elementary particles is permitted or forbidden and describe symmetry classification of elementary particles

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	-	H	H	H	-	M	-	L	H	-	H
CO 2	H	H	-	H	H	H	-	M	-	L	H	-	H
CO 3	H	H	L	H	H	H	M	M	-	M	H	-	H
CO 4	H	H	H	H	H	H	L	M	-	M	H	H	H
CO 5	H	H	L	H	H	H	-	M	-	L	H	-	H

Quantum Mechanics II

Semester: III
23MPHC15

Hours of Instruction/week: 5
Number of Credits: 5

Course Objectives:

1. To learn time independent and time dependent approximation methods
2. To understand relativistic quantum mechanics and its significance
3. To understand the relativistic quantum effects of time varying fields
4. To acquire knowledge on scattering and derive expression for scattering cross section

Unit-I Time Independent Approximation methods:

Introduction- Stationary perturbation theory (non- degenerate case) – Physical application to non- degenerate perturbation theory of ground state of harmonic oscillator - Stark effect in H_2 - Variation method- application to ground state of Helium atom- WKB approximation.

-15hrs

Unit- II Time dependent perturbation theory:

Introduction- time dependent perturbation theory- zeroth order calculation- First order perturbation – transition probability: Fermi-Golden Rule – Second order perturbation- Adiabatic and Sudden Approximation

-15hrs

Unit- III Relativistic wave equation :

Introduction- Development of relativistic quantum mechanics - The Klein Gordon equation - Charge and current densities - The Klein-Gordon equation in Electromagnetic Field.

-15hrs

Unit- IV Dirac's wave equation:

Difficulties of K.G. equation and development of Dirac equation- matrices for α and β- Dirac free particle solution or plane wave solution- Spin of the electron – Electromagnetic potentials: magnetic moment of the electron -Negative energy state of electron: Theory of positron.

-15hrs

Unit -V Scattering Theory :

Scattering Amplitude - Expression in terms of Green's Function - Born Approximation and it's validity - Partial wave analysis - Phase Shifts - Scattering by Coulomb and Yukawa Potential.

-15 hrs

Total Hours:75

References:

1. SatyaPrakash, ***Advanced Quantum Mechanics***, Kedarnath Ram NathCo.,Meerut.(all units), (2001).
2. S.L.Gupta and I.D.Gupta, ***Advanced Quantum theory & Fields***,S.Chand and Company Ltd., New Delhi, (1982).
3. G. Aruldhas, ***Molecular Structure and Spectroscopy***, Asoke K. Ghosh, Prentice Hall of India Pvt., Ltd., New Delhi, (2004).
4. Leonard I Schiff JayendraBandhyopadhyay, ***Quantum Mechanics, (4th edition)***,Mc Graw Hill Education, (2017).
5. V. Devanathan, ***Quantum Mechanics***, Narosa Publishing House, New Delhi, (2005).
6. Lokanthan S Ajoy Ghatak, ***Introduction to Quantum Mechanics***, Laxmi Publications, (2015).
7. R. K. Prasad. ***Quantum Chemistry***,H.S.Poplai for Wiley Eastern Ltd., New Delhi, (1992).

Course Outcomes:

1. Describe time independent perturbation methods and apply those methods to study Stark effect and helium atom
2. Explain time dependent perturbation methods and to derive the expression for transition probability
3. Derive Klein-Gordan equation, charge and current densities
4. Distinguish between relativistic and non-relativistic Hamiltonian and derive Dirac equation and its solution
5. Derive expression for scattering cross section using different formalism, with different potentials

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	M	H	H	H	-	L	-	L	H	-	H
CO 2	H	H	M	H	H	H	-	L	-	L	H	-	H
CO 3	H	H	M	H	H	H	-	L	-	L	H	-	H
CO 4	H	H	M	H	H	H	-	L	-	L	H	-	H
CO 5	H	H	M	H	H	H	-	L	-	L	H	-	H

Numerical Methods (Open Book Test)

Semester: III | **Hours of Instruction/week: 5**
23MPHC16 | **Number of Credits: 5**

Course Objectives:

1. To acquire knowledge on solving equations using numerical methods
2. To understand numerical integration and numerical differentiation methods
3. To learn about probability, distribution and errors

Unit-I Solution of Equations and Eigen value problem:

Linear Interpolation method(Method of False Position)--Newton Raphson method - Bisection method -Basic Gauss elimination method -Gauss Jordan elimination method –Gauss Jacobi iteration method – Inversion of a matrix using Gauss elimination method -Gauss Seidal iteration method. **-15hrs**

Unit-II Interpolation and Numerical Integration:

Newton's forward and backward differences formula to get the derivatives (First and Second order) -Divided differences table to calculate derivatives for unequal intervals Newton -Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule–Error estimates in trapezoidal and Simpson's rule. **-15 hrs**

Unit- III Numerical Differentiation:

Taylor Series-Basic Euler method –Improved Euler method –Modified Euler method–RungeKutta Second and fourth order methods. **-15 hrs**

Unit- IV Curve Fitting and error measurements:

Method of least squares –straight line, parabola , $y = ax^n$, $y = ae^{bx}$, $y = a+bx^n$ type curves. Correlation- comparison of two sets of data- comparison of several sets of data - characteristics of probability distribution- some common probability distributions- Measurement of errors and measurement process – sampling and parameter estimation- propagation of errors **-15 hrs**

Unit- V Probability:

Definition of probability distribution: Discrete, continuous and empirical distribution Expected values: Definition and properties of expected value – Mean, Median, Standard devaition – Variance – Skewness – Kurtosis-Moments. **-15 hrs**

Total Hours:75

References:

1. K. Venkataraman, "***Numerical methods in science and engineering***", National publishing company, Chennai, (2006).
2. P. Kandasamy, K. Thilgavathy, K. Gunavathy, "***Numerical methods***", S.Chand & Company Ltd., New Delhi, (2007).
3. E. Balagurusamy, "***Numerical methods***", Tata McGraw Hill Publishing Company Ltd New Delhi, (2006).
4. John H. Mathews, "***Numerical methods for Mathematics***", Science and Engineering, Prentice Hall, India, (2000).
5. Gerhord Bohm and Gunter Zech ,"***Introduction to statistics and data analysis for Physicists***", (ISBN 978-3-935702-41-6) DOI10.3204/DESY-BOOK/statistics (e-book) <http://www-library.desy.de/elbook.html>
6. S.P.Gupta, "***Statistical Methods***", Sultan Chand and Sons, New Delhi, (2008).
7. K.F. Riley, M.P.Hobson, S.J. Bence, ***Mathematical Methods for Physics and Engineering***, Cambridge University Press, ISBN-13 978-0-II-I6842-0 ebook(EBL), (2006).
8. A. Singaravelu, ***Numerical Methods***, Meenakshi Agency, Chennai (2010)

Course Outcomes:

1. Solve problems using Newton methods and Gauss Jordan methods
2. Solve problems using numerical integration methods
3. Solve problems using numerical differentiation methods
4. Fit curves for a given data
5. Discuss about the fundamentals of probability distributions

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	-	H	M	M	-	L	-	M	H	-	M
CO 2	H	H	-	H	M	M	-	L	-	M	H	-	M
CO 3	H	H	-	H	M	M	-	L	-	M	H	-	M
CO 4	H	H	-	H	M	L	-	L	-	M	H	-	M
CO 5	H	H	-	H	M	L	-	L	-	M	H	-	M

Nanomaterials and Fabrication (Self Study Course)

Semester: III **Hours of Instruction/week: 1**
23MPHC17 **Number of Credits: 4**

Course Objectives:
1. To learn about the Nanoscale materials
2. To gain knowledge on Vacuum Technology
3. To acquire knowledge about fabrication techniques of Nanoscale materials

Unit-I Nanomaterials I:
Carbon: Fullerenes, Carbon Nanotubes - Types of Carbon Nanotubes – Graphene - Porous Materials: Porous Silicon - Aerogels - Types of Aerogels - Zeolites. **-3hrs**

Unit-II Nanomaterials II:
Core-shell Particles – metamaterials - organic-inorganic hybrids: class I and class II hybrids - Intercalation compounds – Ceramics - bioinspiredmaterials : lotus effect (self cleaning) and Gecko effect (Adhesive materials). **-3hrs**

Unit-III Vacuum Technology:
Vacuum Techniques - Vacuum systems - Vacuum Pumps- Rotary Vane pump - Diffusion pump - Sorption pump - Ion pump - Vacuum Gauges: U tube Manometer - McLeod Gauge - Pirani Gauge - Thermocouple Gauge - Cold Cathode Gauge (Penning Gauge) - Hot Cathode Ion Gauge - Bayerd Alpert (B-A) Gauge. **-3 hrs**

Unit- IV Fabrication Techniques I:
PVD: Evaporation - Molecular Beam Epitaxy – Sputtering – CVD - Atomic Layer Deposition – Superlattices - Self Assembly - Langmuir Blodgett films - Electrochemical deposition - sol-gel films. **-3 hrs**

Unit-V Fabrication Techniques II:
Lithography: using photons (UV-VIS, Laser or X Rays) - using particle beam - scanning probe lithography - soft lithography **-3hrs**

Total hours:15

References:

1. Guozhong Cao, ***Nanostructure and Nanomaterials : Synthesis, Properties and Applications***, Imperial College Press, London, (2004)
2. Sulabha K Kulkarni , ***Nanotechnology: Principles and Practices***, Springer Third Edition, (2015)
3. T.Pradeep , ***Nano – the essential***,McGraw Hill Education, Chennai, (2008)

Course Outcomes:

1. Have an idea of the allotropes of Carbon and Zeolites
2. Exposure to various nanomaterials
3. Describe on types of vacuum pumps and gauges
4. Outweigh merits and demerits of fabricating techniques of nanomaterials
5. Analyze employability of lithography techniques.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	M	L	L	L	M	M	-	M	H	M	L
CO 2	H	L	M	L	L	L	M	M	-	M	H	M	L
CO 3	H	L	H	L	L	L	-	M	-	M	H	M	L
CO 4	H	L	M	L	L	L	-	M	-	M	H	M	L
CO 5	H	L	M	L	L	L	-	M	-	M	H	M	L

Practical III General Physics and Electronics

Semester: III
23MPHC18

Hours of Instruction/week:6
Number of Credits: 4

Objectives:

1. To evaluate materials property subjected to magnetic field.
2. To develop essential skills required to construct electronic circuits for filters, oscillators, amplifiers and regulated power supply using integrated circuits
3. To understand programs for analog to digital conversion, digital to analog conversion, waveform generation and seven segment LED display using microprocessor/microcontroller

1. HALL effect
2. Guoy's balance.
3. e/m Thomson's Method.
4. Quinke's Method
5. Young's modulus - Cornus method (hyperbolic and elliptical fringes).
6. Construction of IC regulated dual polarity Power supply (±15V, ±12V)
7. Operation Amplifier filters (low pass, high pass and band pass filters).
8. Operational Amplifier- Wien- Bridge oscillator.
9. Operational Amplifier- Phase shift oscillator.
10. Micro processor interface - stepper motor.
11. Microprocessor – ADC interfacing.
12. Microprocessor DAC interfacing
13. Microcontroller 8051 – Interfacing DAC
14. Microcontroller 8051 – Interfacing stepper motor
15. Microcontroller 8051 – Interfacing wave form generator
16. Microcontroller 8051 – Interfacing seven segment Display
17. SCR Characteristics
18. FET Amplifier

Total hours: 90

Course Outcomes:

1. Distinguish between magnetic materials based on susceptibility and analyze the type of conductivity (p/n) of a semiconductor crystal
2. Design and construct electronic circuits for oscillators, amplifiers, regulated power supplies using integrated circuits
3. Explain the effect of electric and magnetic field on the dynamics of an electron
4. Perform analog to digital conversion, digital to analog conversion, stepper motor using microprocessor
5. Perform interfacing for digital to analog conversion, waveform generation, stepper motor and seven segment LED display using microcontroller

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	H	-	M	-	M	-	L	H	H	-
CO 2	H	L	H	H	-	M	-	M	-	L	H	H	-
CO 3	H	L	H	H	-	M	-	M	-	L	H	H	-
CO 4	H	L	H	H	-	M	-	M	-	L	H	H	-
CO 5	H	L	H	H	-	M	-	M	-	L	H	H	-