KONGUNADU ARTS AND SCIENCE COLLEGE
(AUTONOMOUS)
COIMBATORE -641029

DEPARTMENT OF PHYSICS (PG)

CURRICULM AND SCHEME OF EXAMNINATIONS (CBCS)

(2019-2020 ONWARDS)

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)
COIMBATORE -641029

Vision:

- Developing the total personality of each and every student in a holistic way by adhering to the principles of Swami Vivekananda and Mahatma Gandhi**.**

Mission:

- Imparting holistic and man-making education with emphasis on character, culture and values - moral and ethical.
- Designing the curriculum and other courses that transform its students into value added and skilled human resources.
- Constantly updating academic and management practices towards total quality management and promotion of quality in all spheres.
- Extending the best student support services by making them comprehensive and by evolving a curriculum relevant to student community and society at large.
- Taking steps to make education affordable and accessible by extending scholarships to the meritorious and economically disadvantaged students.
- Motivating teachers in such a way that they become the role models in promoting Higher Education.

DEPARTMENT OF PHYSICS

Vision:

The goal of the Department of Physics is to bring eminence and excellence in teaching learning process and to fetch ours as one of the Benchmark Department with "Potential for Academic excellence"

Mission:

To execute the teaching profession to bring the students as an asset for a productive and fascinating career, successful in their life and to realize learning with real world experience.

PROGRAMME OUTCOME (PO)

Upon successful completion of the Programme, the student will be able to

PO1: Develop knowledge of scientific phenomena, facts, laws, concepts, theories, scientific quantities and their determination, scientific and technological applications as well as their social, economic and environmental implications.

PO2: Think critically; interpret precise concepts to arrive at scientific conclusions.

PO3: Acquire relevant information from a variety of sources and be able to communicate scientific information in a clear, concise and logical manner both verbally and in writing.

PO4: Students are expected to acquire a basic knowledge in various branches of Physics.

PO5: Students are expected to develop written and oral communication skills in communicating Physics related topics.

PO6: Students will realize and develop an understanding of the impact of Physics and Science on the society.

PO7: Apply conceptual understanding of Physics in other disciplines such as Engineering, Mathematics, Computer science and Chemistry.

PO8: Demonstrate the ability to do advanced lab experiments that apply the principles learned in the class rooms.

PROGRAMME SPECIFIC OUTCOME (PSO)

1. Students are expected to acquire a basic knowledge in various branches of Physics.
2. Students are expected to develop written and oral communication skills in communicating Physics related topics.
3. Students will realize and develop an understanding of the impact of Physics and Science on the society.
4. Apply conceptual understanding of Physics in other disciplines such as Engineering, Mathematics, Computer science and Chemistry.
5. Demonstrate the ability to do advanced lab experiments that apply the principles learned in the class rooms.

KONGUNADU ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

COIMBATORE-641 029

M.Sc., PHYSICS

Curriculum and Scheme of Examination under CBCS

(Applicable to students admitted during the Academic year 2019–2020 and onwards)

Semester	Subject code	Title of the Paper	Instruction hours/cycle	Exam. Marks			Duration of Exam. Hrs.	Credits
				CIA	ESE	Total		
I	19PPH101	**C.P 1**- Classical Mechanics	5	25	75	100	3	5
	19PPH102	**C.P 2**- Mathematical Physics	5	25	75	100	3	5
	19PPH103	**C.P 3**- Condensed Matter Physics-I	5	25	75	100	3	5
	19PPH1E1	**1E1-Major Elective 1**	5	25	75	100	3	5
	19PPH2CL	**C. Pr 1**- General Experiments	5	-	-	-	-	-
	19PPH2CM	**C. Pr 2**- Electronics Experiments	5	-	-	-	-	-
			30	**100**	**300**	**400**		**20**

Semester	Subject code	Title of the Paper	Instruction hours/cycle	CIA	ESE	Total	Duration of Exam. Hrs.	Credits
II	19PPH204	**C.P 4**- Quantum Mechanics –I	5	25	75	100	3	4
	19PPH205	**C.P 5**- Thermodynamics and Statistical mechanics	5	25	75	100	3	4
	19PPH206	**C.P 6**- Problems in Physics	5	25	75	100	3	4
	19PPH2E2	**2E2-Major Elective 2**	5	25	75	100	3	5
	19PPH2CL	**C.Pr 1** - General Experiments	5	40	60	100	4	3
	19PPH2CM	**C.Pr 2** - Electronics Experiments	5	40	60	100	4	3
			30	**180**	**420**	**700**		**23**

Semester	Subject code	Title of the Paper	Instruction hours/cycle	CIA	ESE	Total	Duration of Exam. Hrs.	Credits
III	19PPH307	**C.P 7**- Quantum Mechanics-II	5	25	75	100	3	5
	19PPH308	**C.P 8**- Electromagnetic theory and Electrodynamics	5	25	75	100	3	5
	19PPH310	**C.P. 9** Condensed Matter Physics-II	5	25	75	100	3	5
	19PPH3N1	**3N1 – Non Major Elective I**	5	25	75	100	3	5
	19PPH4CN	**C. Pr 3**- Advanced Experiments	5	-	-	-	-	-
	19PPH4CO	**C. Pr 4** - Special Electronics Experiments	5	-	-	-	-	-
			30	**100**	**150**	**400**		**20**

PPH2

IV	19PPH410	**C.P. 10** Communication Physics	5	25	75	100	3	4
	19PPH411	**C.P 11** - Atomic & Molecular Spectroscopy	5	25	75	100	3	4
	19PPH412	C.P 12 - Nuclear and Particle Physics	5	25	75	100	3	4
	19PPH4N2	**4N2 – Non Major Elective II**	5	25	75	100	3	5
	19PPH4CN	**C. Pr 3** - Advanced Experiments	5	40	60	100	6	3
	19PPH4CO	**C. Pr 4** - Special Electronics Experiments	5	40	60	100	6	3
	19PPH4Z1	**Project and Viva Voce**		40	160	200	-	4
			30	**220**	**580**	**800**		**27**
		Total				**2200**		**90**

Note:

- CBCS - Choice Based Credit System
- CIA - Continuous Internal Assessment
- ESE - End of Semester Examination

Major Elective papers

(2 papers are to be chosen from the following 4 papers)

1. **Electronics and Microprocessors**
2. **Applied Physics**
3. Energy Physics
4. Industrial Physics

Non - Major Elective Papers

(2 papers are to be chosen from the following 4 papers)

1. **Nanotechnology: Principles and Applications**
2. **Thin Film Physics, Plasma Physics and Crystal growth**
3. Atmospheric Science
4. Biomedical Instrumentation

Advanced Learner's Course – Advanced Experimental Techniques

Tally Table :

Part	Subject	No. of Subjects	Marks	Credits
I	Core – Theory / Practical / Project	18	1800	70
	Major Elective Paper	2	200	10
	Non-Major Elective Paper	2	200	10
	Grand Total	**22**	**2200**	**90**

- 25% of CIA is applicable to all subjects except JOC, COP and SWAYAM courses which are considered as extra credit courses.
- The students are advised to complete a **SWAYAM- MOOC** before the completion of the 3rd semester and the course completed certificate should be submitted to the HOD. Two credits will be given to the candidates who have successfully completed.
- A **Field Trip** preferably relevant to the course should be undertaken every year.

Components of Continuous Internal Assessment

Components		Marks	Total
Theory			
CIA I	75	(75+75 = 150/10) 15	25
CIA II	75		
Assignment/Seminar		5	
Attendance		5	
Practical			
CIA Practical		25	40
Observation Notebook		10	
Attendance		5	
Project			
Review		30	40
Regularity		10	

BLOOM'S TAXONOMY BASED ASSESSMENT PATTERN

K1-Remembering; **K2**-Understanding; **K3**-Applying; **K4**-Analyzing;**K5**-Evaluating

1. Theory Examination

CIA I & II and ESE: 75 Marks

Knowledge Level	Section	Marks	Description	Total
K1 Q1 to 10	A (Answer all)	10 x 1 = 10	MCQ	75
K2 Q11 to 15	B (Either or pattern)	5 x 5 = 25	Short Answers	
K3 & K4 Q16 to 20	C (Either or pattern)	5 x 8 = 40	Descriptive / Detailed	

2. Practical Examination:

Knowledge Level	Section	Marks	Total
K3	Experiments	50	60
K4	Record Work	10	
K5			

3. Project Viva Voce*:

Knowledge Level	Section	Marks	Total
K3	Project Report	120	160
K4	Viva voce	40	
K5			

* Projects report and Viva voce will be evaluated jointly by Project Supervisor (Faculty of the Department) and an External Examiner.

4. Add On Course

Advanced Learners Course (ALC)

Section A – Multiple Choice (10 × 1 = 10 marks)

Section B – Either or type (5 × 6 = 30 marks)

Section C – Either or type (5 × 12 = 60 marks)

Course Code: 19PPH101

Programme code : 03		M.Sc Physics		
Course Code: 19PPH101		Core Paper 1 – Classical Mechanics		
Batch 2019-2020	Semester I	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to know about the

1. Mechanics of single and system of particle,
2. Generalized coordinates, Lagrangian formulation and mechanics of rigid body motion,
3. Hamiltonian formulation of mechanics, Hamilton-Jacobi theory, harmonic oscillator problem, theory and applications of small oscillations.

Course outcome (CO)

K1	**CO1**	Know about Newtonian mechanics which provides models of the mechanical behavior of objects; conservation principles involving momentum, angular momentum, energy which the fundamental equations of motion.
K2	**CO2**	Get knowledge about coordinate transformations, oscillatory motion, gravitation and other central forces, Lagrangian mechanics and applications of Lagrangian mechanics to solve the physical problems.
K3	**CO3**	Get knowledge about Mechanics of Rigid Body motion.
K4	**CO4**	Know about the theory of small oscillations and its applications

Unit – I **15 hrs**

Mechanics of Single and System of Particles

Newton's laws of motion – Mechanics of a particle- Equation of motion of a particle – Motion of a particle under constant force and alternating force – Mechanics of systems of particles – Angular momentum of the system – kinetic energy of the system – Motion of two particles equivalent to single particle – Equation of motion of centre of mass with respect centre of force – Motion in an inverse square law force field – Classification of orbits.

Unit – II **15 hrs**

Lagrangian Formulation

Generalized coordinates and constraints – principle of virtual work and D'Alembert's principle – Lagrange's equation for a conservative system – velocity dependent potentials and dissipation function. Hamilton's principle – Lagrange's equations of motion from this principle – extension of the principle to non-conservative and non-holonomic systems – conservation theorems and symmetry properties. Applications for Lagrangian and Variational Principle: simple pendulum, compound pendulum, double pendulum, simple harmonic oscillators

Course Code: 19PPH101

Unit - III **15 hrs**

Mechanics of Rigid Body Motion

Generalized coordinates for rigid body motion – Euler's integrals – infinitesimal rotations – Coriollis force – application of a free fall of a body on earth's surface and Foucault's pendulum – moments and products of inertia – Euler's equation of motion – **force free motion of a symmetrical rigid body – heavy symmetrical top under gravity – fast top and sleeping top conditions*.**

Unit - IV **15 hrs**

Hamiltonian Formulation

Hamilton's equation of motion – cyclic coordinates and Routh's procedure – conservation theorem – Hamilton's equation of motion from variational principle – principle of least action – canonical transformation – equations of canonical transformation and generating functions – examples of canonical transformations – integral invariance of Poincare-Lagrange and Poisson's brackets – equations of motion in Poisson bracket notation – Jacobi's identity-infinitesimal contact transformations – angular momentum – Poisson bracket relations – Liouville's theorem.

UNIT – V **15 hrs**

Hamiolton-Jacobi Theory and Small Oscillations

Hamilton-Jacobi equations for Hamilton's principle and characteristic functions – harmonic oscillator problem – separation of variable method – action angle variables – applications – linear harmonic oscillator and Kepler problem – theory of small oscillations – Eigen value equations – normal modes and normal coordinates – application to triatomic molecule.

* **Self study**

Teaching Methods: Seminar / Discussion / Google Classroom / Assignment.

Books for study:

1. Classical Mechanics — Goldstein, Pearson, New International 3rd Edition (2014).
2. Classical Mechanics — Gupta, S.L. Kumar and Sharma, Pragathi Edition (2012).

Books for Reference:

1. Classical Mechanics — Gupta and Sathya Prakash, Kedar Nath Ram Nath & Co (2000).
2. Classical Mechanics — Rana and Joag Tata McGraw-Hill Education (2001).

Mapping					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**S**	**H**	**S**	**S**	**H**
CO 2	**S**	**H**	**S**	**S**	**H**
CO 3	**H**	**S**	**S**	**H**	**S**
CO 4	**S**	**H**	**H**	**S**	**S**
S- Strong	**H-High**		**M-Medium**		**L – Low**

Course Code: 19PPH102

Programme code : 03		M.Sc Physics		
Course Code: 19PPH102		Core Paper 2 - Mathematical Physics		
Batch 2019-2020	Semester I	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to
1. Understand complex variables, group theory & tensors
2. Know about different differential equations and partial differential equations in Physics
3. Study about some of the numerical methods

Course outcome (CO)

K1	**CO1**	Have a good understanding of complex analysis including important theorems and determination of residues to evaluate certain types of definite integrals
K2	**CO2**	Solve physically relevant partial differential equations using the method of separation of variables and be familiar with the most important special functions such as Bessel, Legendre and Hermite to solve differential equations
K3	**CO3**	Have knowledge in abstract group theory and tensors
K4	**CO4**	Apply numerical methods to obtain appropriate solutions to mathematical problems

UNIT I **15 hrs**

Complex variables

Elements of complex analysis –**Taylor and Laurent series** *- Cauchy- Riemann differential equation-Complex line integrals-Cauchy's integral theorem – Cauchy's integral formula-derivatives of an analytic function–Singularities of an analytic function- Residues and their evaluation - Cauchy's residue theorem – Evaluation of definite integrals by contour integration – integration round the unit circle of the type f(cosθ, sinθ)dθ - evaluation of f(x)dx.

UNIT II **15 hrs**

Differential equations

Bessel differential equation: Series Solution –Bessel's function of a first kind- Half order Bessel function - Recurrence formula for $J_n(x)$ – Generating function for $J_n(x)$.
Legendre's differential equation: Series solution Legendre polynomials- Generating function-Recurrance relations – Rodrigue formula - Orthogonality of Legendre's polynomials.
Hermite's differential equation: Series solution – Hermite polynomials – Generating function – Recurrance formula – Rodrigue's formula for Hermite polynomials - Orthogonality of Hermite polynomials

UNIT III **15 hrs**

Group theory and Tensors

Group Theory

Definition of groups – groups of transformation – multiplication table (C_{4v})- conjugate elements and classes – sub groups - cyclic groups - cosets - Lagrange's theorem- normal subgroups - factor subgroups - reducible and irreducible representation of a group- Schur's lemma- orthogonality theorem – construction of character table for C_{2V}.

Course Code: 19PPH102

Tensors

Introduction – n-dimensional space – superscripts and subscripts – coordinate transformation – indicial and summation conventions – dummy and real indices – Kronecker delta symbol – scalars, contravariant and covariant vectors – tensors of higher ranks – algebraic operations of tensors.

UNIT IV **15 hrs**

Partial differential equations in Physics

Introduction – solution of Laplace's equation in Cartesian co-ordinates – solution of Laplace's equation in two dimensional cylindrical co-ordinates(r, θ); circular harmonics- solution of Laplace equation in general cylindrical co-ordinates ; cylindrical harmonics- solution of Laplace's equation in spherical polar co-ordinates; spherical harmonics-diffusion equation or Fourier equation of heat flow- solution of heat flow equation; (method of separation of variables) - two dimensional heat flow - three dimensional heat flow.

UNIT V **15 hrs**

Numerical Analysis

Bisection and Newton – Raphson's method of finding roots of the equation - Giraffe's root squaring method of solving algebraic equation- Gregory-Newton forward &backward interpolation formulae - solution of simultaneous linear equation by Gauss elimination and Gauss - Jordans method – solution of ordinary differential equation by Euler method and Runge - Kutta second and fourth order methods – Evaluation of integral by means of Trapezoidal and Simpson's one third rule.

* **Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Mathematical Physics — Sathya Prakash S. Chand & Sons (2000)
2. Numerical Methods in Science and Engineering — M. K.Venkataraman National Publishing & Co (2001).

Books for Reference:

1. Mathematical Physics — B.D Guptha, Vikas Publishing House 3rd Edition (2006).
2. Elements of group theory for Physicists — A.W. Joshi New age International Publications (2009).
3. Engineering Mathematics — A.Singaravelu, Meenakshi Publishing Co (2000).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
S- Strong		**H-High**		**M-Medium**	**L - Low**

Course Code: 19PPH103

Programme code : 03		M.Sc Physics		
Course Code: 19PPH103		Core Paper 3 – Condensed Matter Physics - I		
Batch 2019-2020	Semester I	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to

1. Understand the crystal system of materials
2. Know about the role of free electron on thermal and electrical conductivity
3. Study about lattice vibrations in crystals

Course outcome (CO)

K1	**CO1**	Understand the fundamental principles and concepts of crystal physics
K2	**CO2**	Applying the reciprocal lattice to the crystal structure and explain how it gives rise to band structure
K3	**CO3**	Expand and evaluate the energy band structure of metal
K4	**CO4**	Acquire knowledge on solid materials

Unit I **15 hrs**

Crystal Structure and Reciprocal lattice

The Space lattices- The Bravais lattices, space lattices and crystal structures – Finding Miller indices of plane, crystal directions and planes, Interplanar distance – Separation between lattice plains in simple cubic, FCC and BCC lattices. Hexagonal closed packed structure (qualitative) - crystal density and packing fraction, The reciprocal lattice- Graphical construction and vector development – Properties of the reciprocal lattice – **Bragg condition in terms of the reciprocal lattice**[*].

Unit II **15 hrs**

Structure determination by X-ray diffraction

Structure factor, Bragg's law of X-ray diffraction, determination of lattice parameters and interplanar spacing from Bragg equation, Powder method of X-ray diffraction, crystal structure determination, condition of reflections for SC, BCC, FCC and DC structures. Evaluation of lattice planes, lattice constant and inter-atomic distance from XRD data.

Bonding in solids

Ionic bonds – Metallic bonds – Van der waals' bonds – Hydrogen bonds – Binding energy of ionic crystals – Evaluation of the Madelung constant – **Binding energy of crystals of inert gases**[*].

PPH10

Course Code: 19PPH103

Unit III **15 hrs**

Crystal imperfections

Classification of imperfections – point imperfections: Frenkel defects and Schottky defect – Line imperfections: Definitions of dislocations, edge dislocation, screw dislocations, Burger's vector, energy of dislocation, surface imperfections: grain boundaries, tilt boundary, twin boundary – Plastic deformation by slip: Shear strength of perfect and real crystals, stress to move a dislocation, the effect of temperature on the stress to move a dislocation.

Unit IV **15 hrs**

Lattice vibrations and thermal properties

The concept of the lattice mode of vibration-Elastic vibrations of continuous media- Phase velocity-group velocity-Vibrations of one dimensional monatomic linear lattice- Vibrations of one dimensional diatomic linear lattice-The concept of phonons-Momentum of phonons-Inelastic scattering of photons by phonons- Inelastic scattering of X-rays by phonons- Inelastic scattering of neutrons by phonons.

Unit V **15 hrs**

Lattice specific heat

Concepts of specific heat - Dulong and Petit's law, Einstein theory of lattice specific heat, Debye theory of lattice specific heat

Free electron theory and Electronic specific heat

Classical free electron theory of metals- Drawbacks of classical theory – Quantum theory of free electrons-Free particle- tunnel effect- Particle in a box (one dimensional)- three dimension box -density of states- Fermi – Dirac distribution function- heat capacity of electron gas-Sommerfeld's quantum theory for electronic heat capacity, electrical and thermal conductivity, Failures of Sommerfeld's theory - **thermoelectric power***.

* **Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Solid State Physics — S.O. Pillai, New age Publishers (2015).
2. Solid state Physics — Puri R.K. & Babbar V.K., S. Chand 6& Co (1997)
3. Material science and Engineering — V. Raghavan, Published Prentice Hall Limited (2015)

Books for Reference:

1. Solid state Physics — Neil W. Ashcroft, Holt, Rinehart and Winston (1976).
2. Introduction to Solid State Physics — Charles Kittel, Wiley India Edition (2012).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	S	S	M	L
CO 2	S	S	S	M	M
CO 3	S	L	S	M	L
CO 4	S	S	S	M	L
CO 5	S	M	S	M	L
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH11

Course Code: 19PPH204

<table>
<tr><td colspan="2">Programme code : 03</td><td colspan="3">M.Sc Physics</td></tr>
<tr><td colspan="2">Course Code: 19PPH204</td><td colspan="3">Core Paper 4 – Quantum Mechanics I</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester
II</td><td>Hours/Week
5</td><td>Total Hours
75</td><td>Credits
4</td></tr>
</table>

Course Objective

1. To impart knowledge on topics of advanced quantum mechanics
2. To understand and to develop problem solving ability on formalism of quantum mechanics, energy Eigen value problems and approximation methods.
3. To understand time dependent and independent theories and perturbation theories.

Course Outcome (CO)

K1	**CO1**	After successfully completing the course, students will be able to spot, identify and relate the eigenvalue problems for energy, momentum and angular momentum.
K2	**CO2**	Solutions of the Schrodinger equation for one and three-dimensional potentials, the square well, the harmonic oscillator and algebraic solution of the harmonic oscillator, barrier penetration and the Ramsauer-Townsend effect will be effectively learned.
K3	**CO3**	This course will introduce Dirac's bra-ket formulation of quantum mechanics and make students familiar with various approximation methods.
K4	**CO4**	The students will be able to understand the time-independent and time-dependent perturbation theory, Schrodinger, Heisenberg and Interaction pictures.

UNIT I **15 hrs**

General formalism of quantum mechanics

Linear vector space – linear operator – **Eigen values and Eigen functions*** – the Hermitian operator – Postulates of Quantum Mechanics – simultaneous measurability of observables – General Uncertainty relation - Dirac's notation – Equations of motion – Momentum representation – related solved problems

UNIT II **15 hrs**

One and three dimensional energy Eigen value problems

Square-well potential with rigid walls – square-well potential with finite walls – square potential barrier – alpha emission – Bloch waves in a periodic potential – Kronig-Penney square-well periodic potential – Linear harmonic oscillator: Schroedinger method

Particle moving in a spherically symmetric potential – spherical harmonics – radial equation – system of two interacting particles – rigid rotator – hydrogen atom – radial equation and its solution – energy eigen values – radial wave functions – wave function of hydrogen like atoms – radial probability density

UNIT III **15 hrs**

Angular momenta and their properties

Angular momentum operator in position representation – spin angular momentum – the total angular momentum operators – commutation relations of total angular momentum with components – Eigen values of J^2 and J_Z – Eigen values of J_+ and J_- - Eigen values of J_X and J_Y - explicit form of the angular momentum matrices – addition of angular momenta: Clebsch Gordan coefficients – properties of Clebsch Gordan coefficients

Course Code: 19PPH204

UNIT IV **15 hrs**

Time independent quantum approximation methods

Stationary perturbation theory (non degenerate case) – evaluation of first order energy and evaluation of first order correction to wave function – normal helium atom – stationary perturbation theory : degenerate case – first order Stark effect in hydrogen atom – The variation method – The WKB method – application of WKB method: probability of penetration of a barrier

UNIT V **15 hrs**

Time dependent perturbation theory

Time development of states – transition probability: Fermi – Golden rule – adiabatic approximation

The semi-classical treatment of radiation

The Einstein coefficients – The atom – field interaction – spontaneous emission rate – the quantum theory of radiation and its interaction with matter: **quantization of radiation field***

* **Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Quantum Mechanics — G. Aruldhas, PHI learning Pvt Ltd (2009).
2. Quantum Mechanics — Gupta, Kumar and Sharma, Jai Prakashnath Co., Meerut (2010).

Books for Reference

1. A text book of Quantum Mechanics — P.M. Mathews and K.Venkatesan,Tata Mc GrawHill education Pvt. Ltd (2004).
2. Quantum mechanics — Leonard. I. Schiff, McGraw Hill Co (2002).
3. Modern quantum mechanics — J J Sakurai, Jim J Napolitino, Pearson new international (2014).
4. Quantum Mechanics: Theory and applications — Ajoy Ghatak and Lokanathan, Macmillan India Ltd (2002).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**S**	**H**	**H**	**H**
CO 2	**H**	**S**	**S**	**S**	**S**
CO 3	**H**	**H**	**H**	**H**	**H**
CO 4	**S**	**S**	**H**	**S**	**S**
S- Strong		**H-High**	**M-Medium**		**L - Low**

PPH13

Course Code: 19PPH205

Programme code : 03		**M.Sc Physics**		
Course Code: 19PPH205		**Core Paper 5 - Thermodynamics and Statistical Mechanics**		
Batch **2019-2020**	**Semester** **II**	**Hours/Week** **5**	**Total Hours** **75**	**Credits** **4**

Objective: To enable the learner to know about

(i) Basic laws in Thermodynamics,
(ii) Classical law and distributions,
(iii) Basic concepts in quantum statistics.

Course outcome (CO)

K1	**CO1**	Know about statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential and apply the concepts and principles of black body radiation to analyze radiation phenomena in thermodynamic systems.
K2	**CO2**	Get knowledge about using the statistical Physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.
K3	**CO3**	Get knowledge about basic concepts and relations including phase space, ensemble, statistical equilibrium, thermal equilibrium and mechanical equilibrium.
K4	**CO4**	Get knowledge about the statistical mechanics of quantum fluids (bosons or fermions), classical limit and strongly degenerate quantum systems, including Fermi gases and Bose-Einstein condensate

UNIT I: Thermodynamics and Radiation **15 hrs**

Second law of thermodynamics- Entropy and Second law of thermodynamics- Entropy and Disorder- Thermodynamic Potential and Reciprocity relation- Thermodynamic Equilibria - Chemical Potential. Black body radiation – Planck's Radiation law.

UNIT II: Basic Concepts **15 hrs**

Phase space- Volume in phase space-Number of phase cells in given energy range of harmonic oscillator- Number of phase cell in the given energy range of 3-dimensional free particle- Concept of ensemble- Micro canonical ensemble-Canonical ensemble- Grand Canonical ensemble- Density distribution in phase space- Liouvilles theorem- Postulate of equal a priori probability- Statistical equilibrium- Thermal equilibrium- Mechanical equilibrium-Particle equilibrium-Connection between Statistical and thermodynamic quantities.

UNIT III: Classical Distribution Law **15 hrs**

Microstates and Macro states-Classical Maxwell-Boltzmann distribution law- Evaluation of constants, α and β- Maxwell's law of Distribution of velocities- Principle of equi-partition of energy - Connection between the partition function and thermodynamic quantities –Boltzman's entropy relation –Perfect gas in micro canonical Ensembles - Gibbs paradox- Partition function and its correlation with thermodynamics quantities- Partition functions and its properties- Comparison of ensembles

PPH14

Course Code: 19PPH205

UNIT IV: Quantum Statistics **15 hrs**

Indistinguishability and quantum statistics- Statistical weight and a priori probability- Identical particle's and symmetry requirements - Bose Einstein' Statistics- Fermi Dirac Statistics – Maxwell – Boltzmann statistics **- Comparison of M-B, B-E, and F-D statistics***- Thermodynamic interpretation of parameter's α and β - Eigen states and the Maxwell Boltzmann equation - Blackbody radiation and Planck radiation- Thermodynamic properties of diatomic molecules Specific heat of solids: Dulong and Pettit's law- Einstein's Theory - Debye theory.

UNIT V: Application of Quantum Statistics **15 hrs**

Ideal Bose Einstein gas:

Energy and pressure of ideal Bose Einstein gas- Gas Degeneracy - Bose Einstein condensation- Thermal properties of Bose Einstein gas-Liquid helium.

Ideal Fermi- Dirac gas:

Energy and pressure of ideal Fermi-Dirac gas – Weak degeneracy – Strong degeneracy at T=0 - Fermi energy –Fermi temperature – Thermodynamic functions of degenerate Fermi - Dirac gas Electron gas - Free electron model and electronic emission.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for Study:

1. Statistical Mechanics — Gupta & Kumar, Pragati Prakashan Meerut (2003).
2. Elements of Statistical Mechanics — Kamal Singh, S.P.Singh, S.Chand & Co Pvt Ltd (1999).

Books for Reference:

1. Fundamentals of Statistical Mechanics — Keiser Huang (2009).
2. Fundamentals of Statistical Mechanics and Thermal Physics — F Reif, McGraw Hill (2010).

Mapping					
	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO 1	**S**	**S**	**H**	**H**	**S**
CO 2	**S**	**H**	**S**	**H**	**S**
CO 3	**S**	**S**	**H**	**S**	**S**
CO 4	**S**	**H**	**S**	**H**	**S**
S- Strong	**H-High**		**M-Medium**		**L - Low**

Course Code: 19PPH206

<table>
<tr><th colspan="2">Programme: 03</th><th colspan="3">M.Sc. Physics</th></tr>
<tr><td colspan="2">Course Code: 19PPH206</td><td colspan="3">Core Paper 6 - Problems in Physics</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester
II</td><td>Hours/Week
5</td><td>Total Hours
75</td><td>Credits
4</td></tr>
</table>

Objectives

1. To impart knowledge and skills to solve problem through the concept behind physics
2. To apply multitude of creative thinking techniques towards realistic problem
3. To visualize the basic concepts clearly

Course outcome (CO)

K1	**CO1**	Understand the problems in classical mechanics, quantum mechanics, electronics and thermodynamics
K2	**CO2**	Segregate the Physics involved in each section of the problem
K3	**CO3**	Recollect the related formulae and apply them in the respective areas necessary
K4	**CO4**	Solve problems in classical mechanics, quantum mechanics, electronics and thermodynamics

UNIT I

Classical Mechanics **15 hrs**

Newton's Laws – Dynamical systems – phase space dynamics – stability analysis – Central force motions–Two body Collisions – Scattering in laboratory and Centre of mass frames–Rigid body dynamics moment of inertia tensor–Non-inertial frames and pseudoforces–Variational principle– Generalized Co-ordinates–Lagrangian and Hamiltonian formalism and equations of motion– Conservation laws and cyclic Co-ordinates–Periodic motion: small oscillations, normal moeds. [Problem no. 1-100, Page No. 148-158, Objective type questions P185-193 (Problems No 1-15)].

UNIT II **15 hrs**

Quantum Mechanics

Wave-particle duality–Schrodinger equation (time-dependent and time-independent) – Eigenvalue problems (particle in a box, harmonic oscillator, etc) –Tunneling through a barrier–Wave-function in co-ordinate and momentum representations–Commutators and Heisenberg uncertainty principle–Dirac notation for state vectors–Motion in a central potential: orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom–Stern-Gerlach experiment–Time-independent perturbation theory and applications. [Problem no. 1-100, Page No. 330-339, Objective type questions P388-398 ((Problems No 1-15)].

Course Code: 19PPH206

UNIT III **15 hrs**

Electromagnetics

Charge density – total charge of the system – distribution of electric charge – Yukawa Potential – Spherically Symmetric charge distribution – Scalar and Vector Functions of an electric field – Electric field inside a uniformly polarized sphere and inside a dielectric – Electrostatic energy of an electron - Coplanar electric dipoles – Array of charges –Repulsion between a point charge and a spherical conductor – Negative charge inside an hydrogen atom – Potential energy of a nucleus. [Problem no. 1-100, Page No. 224-233, Objective type questions P288-293 ((Problems No 1-15)].

UNIT IV **15 hrs**

Electronics

Semiconductor device physics including diodes, junctions, transistors, field effect devices, homo and hetero-junction devices, device structure, device characteristics, Opto-electronic devices including solar cells, photo-detectors, LEDs – Operational amplifiers and their applications- Impedance Matching, amplification (Op-amp based, instrumentation amp, feedback). [Problem no. 1-100, Page No. 570-577, Objective type questions P637-642 (Problems No 1-15)].

UNIT V **15 hrs**

Thermodynamics and Statistical Physics

Laws of thermodynamics and their consequences–Thermodynamics potentials, **Maxwell relations***, chemical potential, phase equilibria –Phase space, micro and macro-states–Micro-canonical, canonical and grand-canonical ensembles and partition functions–Free energy and its connection with thermodynamic quantities. [Problem no. 1-100, Page No. 440-450, Objective type questions P493-498 (Problems No 1-10)].

*** Self study**

Books for study:

CSIR-UGC NET/JRF/SET Physical Science	Dr.SurekhaTomar, Upkar Prakahan, Agra

Books for Reference:

1. Numerical Problems in Physics	Jain K.C. Arora, S.Chand & Company (2012).
2. Problems in Elementary Physics	Bukhovtsev.B.Krivchenkov, CBS Publishers and distributors Pvt Ltd, New Delhi (2012).
3. Modern Physics	R. Murugeshan and Er. Kiruthiga Sivaprasath 17th Revised edition, S.Chand & Company (2014).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
S- Strong	**H-High**		**M-Medium**		**L - Low**

Course Code: 19PPH2CL

Programme code : 03		M.Sc Physics		
Course Code: 19PPH2CL		Core Practical I – General Experiments		
Batch 2019-2020	Semester I & II	Hours/Week 5	Total Hours 150	Credits 3

Course Objective

To enable the learners to

1. Perform experiments in the field of general Physics and gaining physical understanding of the results.
2. Explain physical phenomena and enable to relate physical laws and their applications and hence have a good foundation in Physics.
3. Will be able to apply standard techniques and assess the experimental result and output.

Course outcome (CO)

K5	**CO1**	Have a good foundation in the fundamentals and applications of general Physics
K5	**CO2**	Able to design, carry out record and analyze experimental data.
K5	**CO3**	Provide hands on experiences in conducting scientific investigations and laboratory experiments.
K5	**CO4**	Understand the relationship between theory and experimental results.

List of Experiments <u>(Any fifteen)</u>

1. Young’s modulus-Elliptical fringes (Cornu’s method)
2. Young’s modulus-Hyperbolic fringes- (Cornu’s method)
3. Co-efficient of viscosity of a liquid-Mayer’s oscillating disc
4. Stefan’s constant
5. Rydberg’s constant- solar spectrum
6. Thickness of insulation of a thin wire using laser source
7. Determination of audio frequencies -Wien Bridge method
8. Coefficient of Self-inductance of a coil by Anderson’s bridge method.
9. Forbes method-Thermal conductivity
10. e/m by Millikan’s method
11. e/m by Thomson’s method
12. TCR and band gap energy of thermistor- Carey Foster’s Bridge
13. Ferguson’s method-specific heat of liquid
14. Determination of wavelength by oblique incidence - Grating
15. Determination of wavelength of laser source - Transmission grating
16. Determination of refractive index of a liquid by Air Wedge method

Course Code: 19PPH2CL

17. Determination of refractive index of a liquid by Newton's ring method
18. Laser – Determination of refractive index of given liquids
19. Fizeau's Method – Liner expansion of solids
20. Study of characteristics of Laser
    - i Determination of Gaussian nature of laser source and evaluation of beam spot size.
    - ii Measurement of Laser beam divergence.
    - iii Absorption of light on various filters.

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

Course Code: 19PPH2CM

Programme code : 03		M.Sc Physics		
Course Code: 19PPH2CM		Core Practical II – Electronics Experiments		
Batch 2019-2020	Semester I & II	Hours/Week 5	Total Hours 150	Credits 3

Course Objective

To enable the learners to

1. To design and construct small electronic circuits
2. To develop experimental skills and understand relation between experimental data and theoretical analysis.
3. Have a good foundation in the fundamentals and applications of experimental Physics

Course outcome (CO)

K5	CO1	Acquire a basic knowledge in solid state electronics including FET, UJT and OP AMP.
K5	CO2	Develop the ability to analyse and design analog electronic circuits using discrete components.
K5	CO3	Observe the amplitude frequency response of common amplification circuits.
K5	CO4	Take measurements to compare experimental results in the laboratory with the theoretical analysis.

List of Experiments (Any fifteen)

1. Construction of dual regulated power supply
2. Parameters of Op-Amp
3. Triangular and Square wave generator
4. Wien's Bridge Oscillator
5. Active filters using Op-Amp
6. Monostable and A stable Multivibrator using Op-Amp
7. Phase- Shift Oscillator using Op-Amp
8. Clipping and clamping circuits
9. Differentiating, integrating circuits using Op-Amp
10. Characteristics of Tunnel Diode
11. Characteristics of SCR
12. Characteristics of UJT and UJT relaxation oscillator
13. FET - common source amplifier
14. FET - common drain amplifier
15. Direct Coupled Amplifier
16. Characteristics of MOSFET
17. Characteristics of DIAC & TRIAC
18. Study of Pulse width modulation

Mapping					
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
S- Strong	H-High		M-Medium		L - Low

PPH21

Course Code: 19PPH307

Programme: 03		M.Sc. Physics		
Course Code: 19PPH307		Core Paper 7 - Quantum Mechanics – II		
Batch 2019-2020	Semester III	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to
1. Understand the basic approximate methods in molecular Quantum Mechanics
2. Understand relativistic quantum theory, quantum optics and quantization of fields and scattering

Course outcome (CO)

K1	**CO1**	Understand different approximations and models to describe a many electron system
K2	**CO2**	Comparison of MO and VB theories to explain molecular structure of hydrogen molecule and hydrogen ion
K3	**CO3**	Understand the relation between relativistic theory and quantum mechanics through Dirac's and the related theories. The understandability of spin and negative energy states will be clear.
K4	**CO4**	Interpret scattering theory interms of quantum aspects.

UNIT I **15 hrs**
Many electron atoms:
Indistinguishable particles – Pauli principle – Inclusion of Spin – Spin functions for two electrons - Spin functions for three electrons – The Helium atom – Central Field approximation – Thomas-Fermi model of the atom – Hartree Equation

UNIT II **15 hrs**
Molecular structure:
The Born Oppenheimer Approximation – Molecular orbital theory (LCAO approximation) - Hydrogen molecule Ion – Hydrogen molecule (The MO method) - The valence bond (VB method) – Comparison of MO and VB theories

UNIT III **15 hrs**
Relativistic Quantum mechanics:
Klein Gordan equation – Interpretation of the Klein Gordan equation – Particle in a coulomb field – Dirac's equation for a free particle – Dirac Matrices – Covariant form of Dirac's equation - Probability density – plane wave solution - Negative energy states – spin of the Dirac particle – Magnetic moment of the electron – Spin- Orbit Interaction.

UNIT IV **15 hrs**
Quantum field theory:
Concept of Field and Second Quantization - Quantization of wave field –Lagrangian & Hamiltonian density – Lagrangian & Hamiltonian field equations – Quantum Canonical equations - Quantum equations for the non relativistic Schrödinger equation - Creation,

Course Code: 19PPH307

destruction and number operators – anti commutation relations (basic concepts) – **Quantization of electromagnetic field***

UNIT V **15 hrs**

Quantum theory of scattering

Scattering cross-section – scattering amplitude – Partial waves – Scattering by a central potential: Partial wave analysis – Significant number of partial waves - The Born approximation – scattering by a screened coulomb potential – Validity of Born approximation.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Quantum Mechanics — G Aruldhas, PHI learning Pvt Ltd, II Edition (2009).
2. Introductory Quantum Chemistry — A.K.Chandra, TataMcGrawHill 4^{th} Edition (2010).
3. Quantum Mechanics — Gupta. Kumar. Sharma, Jai Prakash Nath & Co. 29^{th} Edition (2010).

Books for reference:

1. Physics of atoms and molecules — B.H.Bransden and C.J.Joachain, Longman Publication (1983).
2. Quantum Mechanics — A.K.Ghatak and Loganathan, McMillan & Co., IV Edition (2002).
3. A text book of Quantum Mechanics — P. M. Mathews and K.Venkatesan, TATA Mc Graw Hill (2004).
4. Quantum Chemistry — Ira N.Levine, , Prentice Hall, International Inc (1999).
5. Quantum Mechanics — Lenard I Schiff, Tata Mc Graw Hill, New Delhi, III Edition (2002).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**H**	**S**
CO 2	**H**	**H**	**H**	**S**	**H**
CO 3	**S**	**S**	**S**	**H**	**S**
CO 4	**S**	**H**	**H**	**S**	**S**
S- Strong	**H-High**		**M-Medium**		**L – Low**

Course Code: 19PPH308

<table>
<tr><th colspan="2">Programme: 03</th><th colspan="3">M.Sc Physics</th></tr>
<tr><td colspan="2">Course Code: 19PPH308</td><td colspan="3">Core Paper 8 – Electromagnetic Theory and Electrodynamics</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester
III</td><td>Hours/Week
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objective

To know about

1. Theoretical study on electrostatics and magneto statics
2. Applications of Maxwell's equations
3. Antenna Arrays

Course outcome (CO)

K1	**CO1**	Understanding of Maxwell's equations and will be able to manipulate and apply them to EM problems
K2	**CO2**	Define and derive expressions for energy of electrostatics and magnetostatic fields and derive Poynting theorem
K3	**CO3**	Understanding of the propagation and losses of electromagnetic waves in different media.
K4	**CO4**	Study the interaction of electromagnetic waves with different media

UNIT I **15 hrs**

Electrostatics

Dielectric polarization – external field of a dielectric medium – the electric displacement vector, D- linear dielectrics – relation connecting electric susceptibility – P, D and dielectric constant – Molecular field and Clausius – Mosotti relation for non polar molecules – Langevin – Debye formula for polar molecules - **Electrostatic energy and energy density*.**

Magnetostatics

Biot - Savart law statement – Lorentz force law and definition of B – general proof of Ampere's Circuital law – divergence and curl of B – magnetic scalar potential (derivation of expression only) – equivalence of a small current loop and a magnetic vector potential (derivation of expression only).

UNIT II **15 hrs**

Field equation and conservation laws:

Equation of continuity – displacement current – The Maxwell's equations derivation – Physical significance –Poynting vector – momentum in electromagnetic fields-electromagnetic potentials- Maxwell's equation in terms of electromagnetic potentials- concept of gauge – Lorenz gauge-Coulomb gauge-radiation from an accelerated charged particle at low velocity (Larmour formula)- oscillating electric diode- radiation from a small current element – linear half wave antenna **- antenna array***

Course Code: 19PPH308

UNIT III **15 hrs**

Propagation of electromagnetic waves:

Electromagnetic waves in free space – poynting vector of free space (energy flow) plane electromagnetic waves in matter – isotropic dielectric,–in conducting media – poynting vector in conducting media- propagation in ionized gases.

Interaction of EMW with matter on microscopic scale:

Scattering and scattering parameters- scattering by a free election (Thomson scattering) – scattering by a bound electron (Rayleigh scattering) – dispersion in gases – normal and anamolous dispersion in liquids and solids.

UNIT IV **15 hrs**

Interaction of EMW with mater on macroscopic scale:

Boundary conditions at interfaces – reflection and refraction- Frenel's law-Brewster;s law and degree of polarization – total internal reflection and critical angle-reflection from a metal surface- Wave guide(Rectangular) – TE waves – TM waves.

UNIT V **15 hrs**

Relativistic Electrodynamics:

Four vectors – Transformation relation for charge and current densities-for electromagnetic potentials – covariant form of inhomogenous wave equations-covariance of field equation in terms of four vectors –covariant form of electric and magnetic field equations – covariance of electromagnetic field tensor –transformation relation for field vector E and B – covariance form of Lorentz force law.

* **Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Electromagnetic theory — Chopra & Agarwal, K.Nath & Co. 5th edition (2010).
2. Electromagnetics — Gupta Kumar& Singh, Pragathi Prakashan, Meerut (2005).

Book for Reference:

1. Electromagnetic theory and Electrodynamics — Sathya Prakash, Kedar Nath, Ram Nath & Co., 10th Edition (2008).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**H**	**S**	**H**	**H**	**A**
CO 2	**H**	**S**	**S**	**S**	**H**
CO 3	**S**	**H**	**H**	**H**	**H**
CO 4	**H**	**S**	**H**	**H**	**S**
S- Strong	**H-High**		**M-Medium**		**L – Low**

Course Code: 19PPH310

Programme: 03		M.Sc Physics		
Course Code: 19PPH310		Core paper 9 – Condensed Matter Physics-II		
Batch 2019-2020	Semester III	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To gain knowledge about
1. Different types of bonding
2. Polarization effect on dielectric materials
3. Density states of electron

Course Outcome (CO)

K1	**CO1**	Knowledge on structural, semiconducting, superconducting and magnetic properties of crystalline materials
K2	**CO2**	Uunderstand the imperfections in crystals and also lattice vibrations
K3	**CO3**	Knowledge on ferroelectric nature materials
K4	**CO4**	Analyze the effect of temperature, impurity concentration on electrical and magnetic properties of materials.

Unit I **15 hrs**

Band Theory and Electron in a periodic potential

Band theory of solids- Kronig - Penney model- construction of one, two and three dimensional Brillouin zones - Extended, Reduced and Periodic zone schemes – Number of possible wave function in a band-motion of electron in one dimensional periodic potential- Effective mass of an electrons and holes – Classification of materials using band theory, energy bands in metals, semiconductors and insulators

Unit II **15 hrs**

Semiconductors:

Intrinsic semiconductors – Band model- electron and hole concentrations – Law of mass action – Electrical conductivity – Extrinsic semiconductors – Impurity state and Band model – electron and hole concentrations – Impurity electrical conductivity. Variation of electrical conductivity with temperature, energy gaps, Hall effect – Hall parameters - **PN junction and Fermi energy***,

Ordered phase of matter

Translational and orientational order, kinds of liquid crystalline order, quasi crystals.

Course Code: 19PPH310

UNIT III **15 hrs**

Magnetism

Langevin's theory of diamagnetism - quantum theory of diamagnetism of mono nuclear systems – Paramagnetism – quantum theory of paramagnetism: rare earth ions. Ferromagnetism – Spontaneous magnetization - Weiss theory of spontaneous magnetization – Hysteresis – Weiss theory of Hysteresis – Ferromagnetic domains – Antiferromagnetism – Molecular field theory – Susceptibility above and below Neel temperature – Ferrimagnetism – Molecular field theory of Ferrimagnetism.

Unit IV **15 hrs**

Dielectrics and Ferroelectrics

Maxwells equation – Polarization –Macroscopic Electric field : depolarization electric field – Local electric field in an atom – Lorentz field –field of dipoles inside a cavity – dielectric constant and polaizability: Electric polarizability – structural phase transtition – Ferroelectric crystals – classification of ferroelectrics crystal – Displacive Transition :soft optical phonon – antiferroelectricity and ferroelectric domains – Piezoelectricity, **pyroelectricity***, ferroelasticity.

Unit V **15 hrs**

Superconductivity

Mechanism of super conductivity - Critical currents - Meissner effect- Thermal properties-- Energy gap-Isotope effect-penetration depth -Type I and Type II superconductors- London equation-superconductors in AC fields-Thermodynamic of superconductors- BCS theory of superconductivity –Quantum tunneling- Josephson superconductor tunneling – DC Josephson effect – AC Josephson effect - **Macroscopic Quantum interference* -** SQUID**.**

***Self-study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Solid state Physics — S.O. Pillai, New age Publishers (2015).
2. Solid state Physics — Puri R.K. & Babbar V.K., S. Chand & Co (1997)
3. Solid state Physics — RL. Singhal, Kedar Nath Ram Nath (2019).

Books for Reference:

1. Solid state Physics — Neil W. Ashcroft, Holt, Rinehart and Winston (1976).
2. Introduction to Solid State Physics — Charles Kittel, Wiley India Edition (2012).
3. Material science and Engineering — V. Raghavan, Published Prentice Hall Limited (2015).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	M	S	M	S
CO 2	S	S	M	S	S
CO 3	S	S	S	S	S
CO 4	S	S	S	S	S
S- Strong	**H-High**		**M-Medium**		**L - Low**

Course Code: 19PPH410

Programme: 03		M.Sc Physics		
Course Code: 19PPH410		Core paper 10 - Communication Physics		
Batch 2019-2020	Semester IV	Hours/Week 5	Total Hours 75	Credits 4

Course Objective

To enable the learners to understand

1. Various modulation and detection techniques
2. Generation and propagation of microwaves
3. Radar and communication electronics

Course Outcome (CO)

K1	**CO1**	Knowledge about wireless and wired telephony communication systems
K2	**CO2**	Understand the working principles of Radio, Television, Radar and Satellite communication
K3	**CO3**	Knowledge on modeling of different types of antennas and microwave generation
K4	**CO4**	Able analyze the problems involved in designing of wireless communications devices

UNIT I **15 hrs**

Modulation and Detection

Need for modulation – Modulation index - Principles of AM and FM with circuit diagrams – Comparison of DSB, SSB, DSBSC and VSB transmission – Multichannel communications (FDM, TDM) – AM detection – Frequency discriminator and ratio detector.

UNIT II **15 hrs**

Antennas and Wave Propagation

The elementary doublet - Terms and definitions in connection with antennas and their radiation patterns – Effect of ground on antennas – Effect of antenna height - Antenna coupling at medium frequencies - Dipole arrays-Yagi Uda antenna – Broad side and End fire array - Wide band and special purpose antennas, Folded dipoles, helical antenna, discose antenna and phased arrays – Ground wave propagation - Sky wave propagation **– Line of sight***

UNIT III **15 hrs**

Television and Radar

Black and White TV Transmission – Black and White TV Reception – Color TV Transmission and Reception - Elements of a RADAR system – The RADAR equation – Radar performance factors – Radar Transmitting systems – Radar Antennas - Duplexers - Radar Receivers and Indicators – Pulsed systems

UNIT IV **15 hrs**

Communication Electronics

Fundamentals of Data Communication systems – Data Sets and interconnection requirements – Network and control considerations – Multiplexing – Short and Medium Haul systems – Long Haul systems – Elements of Long distance Telephony – Satellite communication – **Features of a communication network –TYMNET, ARPANET, ISDN, LAN***

Course Code: 19PPH410

UNIT V **15 hrs**

Microwaves

Microwave generation – Multicavity Klystron -Reflex Klystron – Magnetron, TWT and other microwave tubes - Microwave transistors – Microwave integrated circuits – Parametric Amplifiers –Tunnel Diode – Gunn Diode.

* **Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment/ Google Classroom.

Books for study:

1. Electronics Communication systems — George Kennedy Davis, Tata McGraw Hill 4th Edition, New Delhi (2008).
2. Principles of Communication Engineering — Anokh Singh & A.K.Chhabra, S.Chand and Co., (1999).

Books for Reference:

1. Electronics and Radio Engineering — F.E. Terman, McGraw Hill, 4th Edition (1957).
2. Communication systems — Simon Haykin, John Wiley and Son Inc. 5th Edition (2010).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH29

Course Code: 19PPH411

Programme: 03		**M.Sc Physics**		
Course Code: 19PPH411		**Core Paper 11 - Atomic and Molecular Spectroscopy**		
Batch **2019-2020**	**Semester** **IV**	**Hours/Week** **5**	**Total Hours** **75**	**Credits** **4**

Course Objective

To study about the

1. Atomic Spectroscopy, Microwave Spectroscopy, IR Spectroscopy and Raman Spectroscopy
2. Electronic Spectra of diatomic molecules
3. NMR and AQR Spectroscopy.

Course outcome (CO)

K1	**CO1**	Explain the different spectroscopic methods for qualitative and quantitative analysis
K2	**CO2**	Explain electronic transitions, atomic spectra, excited states, hydrogenic and multielectron atoms.
K3	**CO3**	Understanding of quantum chemical principles
K4	**CO4**	Knowledge about binding of atoms into molecules, molecular degrees of freedom (electronic, vibrational and rotational) and elementary group theory.

UNIT I **15 hrs**

Atomic spectroscopy

Spectra of the alkali metal vapours– Elements with more than one outer valence electron – magnetic moment and space quantization of angular momentum– The magnetic moment of the atom – Normal Zeeman effect – Anamalous Zeeman effect– Emitted transitions in anomalous Zeeman transitions – The Lande's 'g' formula – The Paschen Back effect – hyperfine structure of spectral line – Zeeman effect of hyperfine structure – the Back-Goudsmit effect.

UNIT II **15 hrs**

Microwave Spectroscopy

The rotation of molecules – rotational spectra of rigid diatomic molecules – the intensities of spectral lines – the non rigid rotator – the spectrum of a non-rigid rotator – symmetric top molecules

IR Spectroscopy

The vibrating diatomic molecules – The simple harmonic oscillator – The anharmonic oscillator – The diatomic vibrating rotator – fundamental vibrations and their symmetry – The influence of rotation on the vibrational spectra of polyatomic molecules – linear molecules – symmetric top molecules.

Unit III **15 hrs**

Raman spectroscopy

Quantum theory – Classical theory – pure rotational Raman spectra – linear molecules – symmetric top molecules – Raman activity of vibrations – Rule of mutual exclusion – Vibrational Raman spectra – Rotational fine structure .

Electronic spectra of diatomic molecules

Vibrational coarse structure – Deslandres tables – Frank-Condon principle – rotational fine structure of electronic – vibrational transition

Course Code: 19PPH411

UNIT IV **15 hrs**

NMR spectroscopy:

Quantum mechanical and classical description – The Bloch equations - Relaxation processes- spin lattice and spin relaxation – Fourier transformation - Experimental technique- principles and working of Fourier transform NMR spectrometer- chemical shift.

NQR spectroscopy:

Fundamental requirements - general principles – Half integral spins – Integral spins experimental detection of NQR frequencies.

UNIT V **15 hrs**

ESR Spectroscopy:

Basic principles of ESR – experiments - ESR Spectrometer - Reflection cavity and microwave bridge – ESR spectrum- **Hyperfine structure – Study of free radicals*.**

Mossbauer Spectroscopy:

The Mossbauer effect – The recoilless emission and adsorption – The Mossbauer spectrum- experimental methods.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar /Discussion / Assignment / Google Classroom.

Books for study:

1. Fundamentals of Molecular Spectroscopy C.N. Banwell and E.M. Mc Cash, Tata McGraw Hill Pub.Co, 4^{th} Edition (1994).
2. Spectroscopy B.P.Straughan and S.Walker, John Wiley Wiley & Sons Inc., Newyork (1976).

Books for Reference:

1. Elements of spectroscopy Gupta Kumar, Pragathi Prakasan pub. Co., Meerut (2007).
2. Molecular structure and spectroscopy G. Aruldhas, Prentice Hall of India (2002).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**H**	**H**	**H**
CO 3	**H**	**S**	**H**	**H**	**S**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH31

Course Code: 19PPH412

Programme code : 03		M.Sc Physics		
Course Code: 19PPH412		Core Paper 12 - Nuclear and Particle Physics		
Batch 2019-2020	Semester IV	Hours/Week 5	Total Hours 75	Credits 4

Course Objective

To study about the

1. Basic nuclear structure
2. Radio - Alpha decay, Beta decay and Gamma decay
3. Nuclear Models: Liquid Drop Model, Shell Model

Course Outcome (CO)

K1	**CO1**	Be able to study the structure of a nucleus and about nuclear forces
K2	**CO2**	Be able to understand the various types of decays in radioactive elements
K3	**CO3**	Have a thorough knowledge of the different nuclear models and different types of nuclear reactions
K4	**CO4**	A thorough knowledge about elementary particles

UNIT I **15 hrs**

Radioactivity

Discovery of radioactivity- Radioactive disintegration and displacement law- growth and decay of radioactivity- successive disintegrations- radioactive equilibrium - Discovery of radium- Unit of radioactivity- mean life of a radioactive substance – measurement of decay constant- half life of complex decays- age of minerals and rocks.

UNIT II **15 hrs**

Alpha particles

Determination of q/m of alpha particles - determination of charge and mass - identification of alpha particles - determination of velocity - disintegration energy - range.

Beta particles

Determination of specific charge - Bucherer's experiment - Beta energy - Fermi's theory of allowed beta decay - allowed and forbidden transitions - selection rules.

Gamma rays

Nature of Gamma rays – passage - photoelectric absorption -Compton scattering - electron - positron pair production and annihilation.

UNIT III **15 hrs**

Determination of some nuclear properties

Dempster's mass spectrometer- Aston's mass spectrograph-Bainbridge's first mass spectrograph-Double focusing mass spectroscopes-nuclear spin from Zeeman Effect of hyperfine lines-nuclear spin and statistics from molecular spectra-magnetic resonance method of Rabi-absorption method-nuclear induction method-microwave spectroscopy method-electric quadrupole moments of nuclei.

PPH32

Course Code: 19PPH412

UNIT IV **15hrs**

Nuclear models

Constitution of nucleus; neutron-proton hypothesis-nuclear models-liquid drop model-Bethe-Weizsacker formula-applications of semi empirical binding energy formula-Fermi gas model of the nucleus-Nuclear shell structure-Single particle shell model-individual particle model-collective model.

UNIT V **15 hrs**

Particle Physics

Hadrons – Hyperons – Pion – Meson resonances – strange mesons and Baryons – Gellmann Okubo mass formula for Baryons – CP violation in K decay – Quark model – Reaction and decays – quark structure of Hadrons.

***Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Nuclear Physics — S.N. Ghoshal S. Chand and Co. New Delhi (2010).
2. Elements of Nuclear Physics — Yadav and Pandya K.Nath Ram Nath Co., (2000).

Books for Reference:

1. Concept of Nuclear Physics — Bernard L. Cohen Tata Mc Graw Hill Publishing (2004).
2. Introduction of Modern Physics — Kenneth S. Karne John Hile and Sons, New York (1998).
3. Nuclear Physics — R. Murugesan, S. Chand and Co (1999).
4. Nuclear Physics — R.C. Sharma K. Nath & Co., Meerut(2004)
5. Nuclear Physics — D.C. Tayal Himalayan Publishing House, Bombay (2002).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	H	S	H	
CO 2	S	H	H	S	S
CO 3	H	S	S	S	H
CO 4	S	H	H	H	S
S- Strong		**H-High**	**M-Medium**		**L - Low**

PPH33

Course Code: 19PPH4CN

<table>
<tr><td colspan="2">Programme: 03</td><td colspan="3">M.Sc. Physics</td></tr>
<tr><td colspan="2">Course Code: 19PPH4CN</td><td colspan="3">Core Practical III – Advanced Experiments</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester
III & IV</td><td>Hours/Week
5</td><td>Total Hours
150</td><td>Credits
3</td></tr>
</table>

Course Objective

To enable the learners to
1. Perform experiments in the field of advanced Physics and interpret the results.
2. Explain physical phenomena and enable to estimate various related parameters and to analyze them.
3. Apply the experimental techniques to the research level

Course outcome (CO)

K5	**CO1**	Fundamental knowledge on applications of advanced Physics.
K5	**CO2**	Understand the relationship between theory and experiments
K5	**CO3**	Provide hands on experiences in conducting scientific investigations and laboratory experiments.
K5	**CO4**	Design, carry out record and analyze experimental data.

List of Experiments (Any Fifteen)

1. Development of Copper/Brass/Iron Arc spectra – Constant Deviation Spectrograph
2. Magnetic field Strength determination – Search Coil method
3. Determination of Magnetic Susceptibility of the given solutions – Quincke's method
4. Determination of Magnetic Susceptibility of the given solutions – Guoy's method
5. Bulk modulus and Compressibility of the liquids – Ultrasonic diffraction
6. Hall Effect- Measurement of Hall parameters of Hall probe, n-type and p-type semiconductors
7. e/m – Zeeman effect
8. e/m – Magnetron method.
9. e/m – Helical method
10. B-H curve - Anchor ring
11. B-H curve - Solenoid
12. I-H curve - Solenoid
13. Kelvin's double Bridge – Determination of very low resistance and specific resistance of different metals.
14. Determination of Planck's constant - Photo Cell.
15. To determine the resistivity of a Semiconductor material - Four Probe method.
16. Michelson interferometer – determination of λ, $d\lambda$ and thickness of mica sheet.
17. Optoelectronics Experiments.

Course Code: 19PPH4CN

18. G.M Counter
19. Fiber optic Experiments - Determination of Numerical aperture, acceptance angle and Fiber Loss of an optical fiber
20. Optical bench – Biprism – Determination of λ of a monochromatic light.

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**S**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH35

Course Code: 19PPH4CO

Programme: 03		**M.Sc. Physics**		
Course Code: 19PPH4CO		**Core Practical IV – Special Electronics Experiments**		
Batch **2019-2020**	**Semester** **III & IV**	**Hours/Week** **5**	**Total Hours** **150**	**Credits** **3**

Course Objective

To enable the learners to

1. To design and construct small electronic circuits
2. To develop experimental skills and understand relation between experimental data and theoretical analysis.
3. Have a good foundation in the fundamentals and applications of experimental Physics

Course outcome (CO)

K5, K6	**CO1**	Acquire a basic knowledge in solid state electronics including OP AMP and 555 timer and understand the ALP using 8085 processor
K5, K6	**CO2**	Develop the ability to analyze and design analog electronic circuits using discrete components.
K5, K6	**CO3**	Observe the physical entities by constructing a sensor circuits such as temperature and light intensity using Op-amp
K5, K6	**CO4**	Take measurements to compare experimental results in the laboratory with the theoretical analysis and also simulate the ALP for the interfaces such as Traffic control, Stepper motor and A/D, D/A converters

List of Experiments (Any Fifteen)

1. Op. amp - V to I & I to V converters.
2. Op. amp - D/A converter-Binary weighted, Ladder methods
3. Op. amp - Log and Antilog amplifiers.
4. Op. amp - Half wave, Full wave & Peak value Clippers and Clampers
5. Op. amp - Comparator-Zero crossing detectors, Window detector, Time marker.
6. Op-amp- Simultaneous Addition and Subtraction
7. Op-amp- Instrumentation amplifier-Light intensity-Inverse square law
8. 555 Timer -Schmitt trigger & Voltage controlled oscillators
9. 555 Timer - Monostable & Astable multivibrators
10. Study of Flip Flops
11. Study of Semiconductor Memory - ROM
12. Microprocessor - LED interfacing (Rolling display)
13. Microprocessor - Stepper motor interfacing
14. Microprocessor - Traffic control simulation
15. Microprocessor - ADC interface
16. Microprocessor – DAC - Wave form generator
17. Microprocessor - Hex key board interfacing
18. Microprocessor - Musical tone generator
19. Microprocessor - Temperature controller

Course Code: 19PPH4CO

Mapping					
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	S
CO 3	S	H	S	S	H
CO 4	S	H	S	H	H
S- Strong	H-High		M-Medium		L - Low

Course Code: 19PPH4Z1

Programme: 03		M.Sc. Physics		
Course Code: 19PPH4Z1		Project Work and Viva-Voce		
Batch 2019-2020	Semester IV	Hours/Week -	Total Hours -	Credits 4

Marks Distribution

CIA/ESE	Particulars	Marks
CIA	Project Review	30
	Regularity	10
	Total Internal Marks	**40**
*ESE	Project Report Presentation	120
	Viva Voce	40
	Total External Marks	**160**
Total Marks (CIA + ESE)		**200**

* Projects report and Viva voce will be evaluated jointly by Project Supervisor and an External Examiner.

MAJOR ELECTIVE PAPERS

(2 papers are to be chosen from the following 4 papers)

1. **Electronics and Microprocessors**
2. **Applied Physics**
3. Energy Physics
4. Industrial Physics

Course Code: 19PPH1E1

Programme code : 03		M.Sc Physics		
Course Code: 19PPH1E1		Major Elective Paper1- Electronics and Microprocessors		
Batch 2019-2020	Semester	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To study about the

1. Power electronics, operational amplifiers and its applications and non-linear IC circuits
2. Instruction set, interfacing and programming of 8085 microprocessors.
3. Architecture of microprocessors.

Course Outcome (CO)

K1	**CO1**	Will get knowledge on crystalline and amorphous nature of semiconductors
K2	**CO2**	Will be able to understand the method of preparation of thin films
K3	**CO3**	Will apply knowledge on Photolithography for manufacturing of LED
K4	**CO4**	Will be able analyze the problems in LED production and its performance

UNIT I **15 hrs**

Power Electronics

Power electronics – Triac – triac construction- triac operation – triac characteristics – Applications of triac - Diac – Applications of diac – Unijunction transistor (UJT) – UJI – Equivalent circuit – Characteristics of UJT - Applications of UJT.

UNIT II **15 hrs**

Amplifiers and Nonlinear integrated circuits

Operational Amplifiers - Inverting amplifiers, non-inverting amplifiers-differential amplifier – integrator and differentiator* – logarithmic amplifiers and multipliers – filters - voltage to current converters – sample and hold circuits- high input impedance amplifiers – instrumentation amplifiers- sensing amplifiers and comparators – zero crossing detectors – window detector – Time marker.

UNIT III **15 hrs**

Microprocessors Architecture

Introduction –Intel 8085-pin diagram- Architecture-Instruction cycle –Timing diagram for OP code fetch cycle –Memory read –Memory write –I/O read-I/O write –Instruction set – Addressing mode.

UNIT IV **15 hrs**

Peripheral devices and their interfacing

Introduction –Addressing space partitioning – Memory and I/O interfacing –Programmable peripheral interface Intel 8255 –Programmable DMA controller Intel 8257- Programmable communication interface Intel 8251-Programmable counter/Time interval Intel 8253

Course Code: 19PPH1E1

UNIT V

Microprocessor based data acquisition system and applications

Introduction –Analog to digital converter (ADC)-Digital to analog (DAC)-Microprocessor –LED Interfacing –Stepper Motor Interfacing –Traffic control simulation –Music tone generator –Temperature controller.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Integrated Electronics — Millman and Hilkais, Tata McGraw Hill Publications (1983).
2. Fundamentals of Microprocessors & Microcontrollers — B.Ram, Dhanpat Rai Publications (2011).

Books for Reference:

1. Principles of Electronics — V.K.Mehta, S.Chand & Company (2014).
2. Electronic devices Applications and Integrated circuits — P. Mathur, C. Kulshreshta and R.Chada, Umesh Publications (2005).
3. Linear integrated circuits — D Roy Choudhary, Shail B. Jain, New age Int Pub. (2014).
4. Introduction to Integrated electronics digital and analog — V.Vijayendaran, S.Vishwanathan, Printers and Publishers Pvt. Ltd (2011).
5. Digital Principles and Applications — Albert Paul, Malvino, McGraw Hill Publications (1997).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**H**	**S**
CO 2	**S**	**S**	**S**	**S**	**H**
CO 3	**H**	**M**	**S**	**S**	**S**
CO 4	**H**	**S**	**S**	**H**	**S**
CO 5	**S**	**S**	**H**	**S**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

Course Code: 19PPH2E2

<table>
<tr><td colspan="2">Programme code: 03</td><td colspan="3">M.Sc., Physics</td></tr>
<tr><td colspan="2">CourseCode: 19PPH2E2</td><td colspan="3">Major Elective Paper 2- Applied Physics</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester</td><td>Hours/Week
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objectives

i. To impart knowledge on semiconducting materials
ii. To understand the working of solar cells and LED
iii. To impart knowledge on different deposition technique

Course outcome (CO)

K1	**CO1**	Able to identify the different type semiconducting materials
K2	**CO2**	Able to describe the working of solar cells
K3	**CO3**	Able to design the experiment to estimate the device parameters
K4	**CO4**	Able to apply the knowledge on synthesis / deposition of different semiconductors and to demonstrate the potential applications.

UNIT I
Growth techniques **12 hrs**

Important elemental and compound semiconductors - Ge, Si, Se, Te, II-VI,III-V, IV-VI and amorphous Si. Crystal growth techniques - float zone - Czochralski-hydrothermal growth - growth of GaAs-production of Si and GaAs**.**

UNIT II **12 hrs**
Properties of Semiconductors

Semiconductors (Crystalline and amorphous)- band structure of crystalline and amorphous semiconductors (qualitative). Carrier concentration – mobility lifetime. Optical properties of solids - Optical constants-fundamental absorption in semiconductors- direct and indirect transmission, **Photoconductivity**, Photoluminescence

UNIT III **12 hrs**
Junction Physics

p-n junction-depletion region and depletion capacitance (abrupt junction)-current-voltage characterization-heterojunction-depletion layer- photodiodes - avalanche photodiodes – Light emitting diodes – Liquid crystal display.

UNIT IV **12 hrs**
LASER

Semiconductor lasers - transition process - population inversion-threshold current density-Production of laser diodes: planar epitaxial technology - Fabrication of integrated circuits Photolithography – Etching

Course Code: 19PPH2E2

UNIT V **12 hrs**

Solar cells

Solar cells – Solar cell parameters - Solar cell basic characteristics - spectral response, recombination – short circuit current, open circuit voltage and series resistance - Generation of solar cells – Preparation techniques

*** Self study**

Teaching Methods: PowerPoint presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1.	Physics of Semiconductor devices	S. M. Sze , Willey online Library (2008)
2.	An Introduction to Solid State Physics and its applications	R.J.Elliot and A.P.Gibson Macmillan, (1974)
3.	Optical Electronics	A.Yariv, Saunders College Publishing. (1991)

Books for Reference:

1.	Semiconductors	R.A.Smith,Cambridge University Press, (1959)
2.	Crystal Growth	B.R.Pamplin, Pergamon Press, (1975)

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**H**	**H**	**S**	**S**
CO 3	**S**	**S**	**H**	**H**	**H**
CO 4	**H**	**S**	**S**	**H**	**H**
S- Strong		**H-High**	**M-Medium**	**L - Low**	

PPH43

Programme code : 03	M.Sc Physics			
Major Elective Paper 3 - Energy Physics				
Batch 2019-2020	Semester	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the leaners

1. To know about solar radiation & solar pond
2. To know about photovoltaic energy conversion
3. To know hydrogen energy, wind energy & OTEC
4. To understand the importance of energy auditing and carbon credits.

Course Outcome (CO)

K1	CO1	Understand the nature of solar radiations and the conversation of solar radiation into thermal energy by means of solar energy collectors
K2	CO2	Understand the basics of solar energy conversion, material selection for solar cells and its applications
K3	CO3	Know the principles of wind energy conversion, basic components of conversion system and its application
K4	CO4	Know the principles of energy conservation and energy audit, global climate change, carbon credits & its implantation projects.

UNIT I **15 hrs**

Solar thermal energy

Introduction on solar radiation - solar constant - solar radiation at the earth surface - physical principles of the conversion of solar radiation into heat solar energy collectors - flat plate collectors - advantages of flat plate collectors - concentrating collector parabolic through reflectors and mirror - strip reflector - advantages and disadvantages of concentrating collectors over flat plate type collectors - solar energy storage - solar pond - principle of operation and description of non-convective solar pond - **applications of solar ponds***.

UNIT II **15 hrs**

Solar photovoltaic energy

Solar photovoltaic: Introduction - Fundamentals of photovoltaic conversion - semiconductor materials - photon energy - electron - hole concentration and Fermi level –A p-n junction – light absorption in a semi conductor- solar cell materials - efficiency of solar cells - silicon solar cell - polycrystalline & amorphous silion cells - **photovoltaic applications***.

UNIT III **15 hrs**

Wind and Ocean thermal energy

Introduction - Basic principles of wind energy conversion – nature of wind - the power and the wind - forces on the blades and thrust on turbines - wind energy conversions - site selection conservations - basic components of the wind energy conversion system - classification of WEC systems - advantages and disadvantages of WECs - energy storage - applications of wind energy.

Ocean thermal energy

Introduction: Ocean thermal energy conversion (OTEC) – methods of ocean thermal electric power generation - open cycle OTEC system - heat exchangers - bio-fouling – site selection – energy utilization - hybrid Cycle.

UNIT IV **15 hrs**

Hydrogen energy and Fuel cells

Hydrogen energy

Introduction - hydrogen production - electrolysis or the electrolytic production of hydrogen - solar energy methods - bio-photolysis and photo-electrolysis - hydrogen storage – hydrogen transformation - utilization of hydrogen gas - electric power generation - hydrogen in fuel cells - **Hydrogen as an alternative fuel for motor vehicles ***- safety and management.

Fuel Cells:

Introduction – Principle of operation of a fuel cells - classification of fuel cell - hydrogen fuel cells - Advantages and disadvantages of fuel cells - applications of fuel cells.

Unit V **15 hrs**

Energy Auditing and Carbon Credit

An Economic concept of Energy – Principles of Energy conservation and Energy Audit - types of energy Audits – **Global Climate change - Greenhouse effect*** – Emissions from Combustion of Natural gas.

Emission trading: The definition and concept – carbon credits – carbon currency – carbon credits under Kyoto Protocol.

Trading of Carbon Credits and India's perspectives – Implementing of CDM projects in India – Potential CDM projects in India.

***Self-study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Solar energy fundamentals and applications	H.P. Garg and J. Prakash, McGraw Hill (2002).
2. Solar Cell Device Physics	Stephen J.Fonash, Elsevier Publishers (2010).
3. Non-Conventional Energy Sources	G.D.Rai, Fifth Edition, Khanna Publishers (2014).

Books for Reference:

1. Fundamentals of solar cells	Fahrebruch & Bube, photovoltaic solar energy Academic Press (1983).
2. Hydrogen as an energy carrier	Winter & Nitch, Springer, New Delhi (1988).
3. Fundamentals of energy engineering	Albert Thumann, The Fairmont Press (1984)

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH46

Programme code : 03		M.Sc Physics		
Major Elective Paper 4 - Industrial Physics				
Batch **2019-2020**	**Semester**	**Hours/Week** **5**	**Total Hours** **75**	**Credits** **5**

Course Objective

To enable the learners to
1. Understand the working of SCR, UJT, Jones circuit and Triac circuits.
2. Understand the construction and working of flip-flops, registers converter and microprocessors.
3. Understand the working of the production of vacuum and construction of pumps and gauges
4. Understand the working of heating system, photodiode, gauges etc.,

Course Outcome (CO)

K1	**CO1**	Get knowledge on different types of transistors, regulators and microprocessors
K2	**CO2**	Understand the working mechanism of SCR, Flip-flops, Thermocouple and vacuum gauges
K3	**CO3**	Apply knowledge on vacuum techniques, applications of SCR, Switching circuits and Industrial heating systems
K4	**CO4**	Able analyze the problems involved in biasing of transistors, industrial transducers and production of vacuum

UNIT I **15 hrs**

Time-delay action – RC time constant. Direct coupling of transistor- Darlington circuit – Differential Amplifier, Uni junction transistor – Silicon Controlled Rectifiers (SCR) - SCR in simple AC circuits – phase control of the SCR – firing by UJT- phase control by pedestal and ramp – turn off of SCR. Jones circuit - Triac circuits – **Zero voltage switching circuit*.**

UNIT II **15 hrs**

Regulators of voltage and motor speed – voltage compensator – DC voltage regulated DC regulated Power supplies. Inverters – multivibrator inverter – two SCR inverter. Closer loop systems – Servomechanisms – basic part of a serve – complete serve diagram – loop gain – PID controllers.

UNIT III **15 hrs**

Switching and counting circuits – flip-flops – shift register – serial to parallel converter. MOS gates – complementary MOS – digital to analog converter – sample and hold information conversion – parallel to serial converter – multiplexer – addressing – BCD and octal binary codes – numeric displays - microprocessor and its operation (elementary ideas).

UNIT IV **15 hrs**

Industrial heating systems – electron beam heating – microwave heating – induction heating. Measurement of light , PMT – photodiode – IR detectors – Temperature – Thermocouple amplifiers - optical pyrometer – strain – strain gauges – electrochemical transducers – pH.

UNIT V **15 hrs**

Production of vacuum – rotary pumps – diffusion pumps – ion getter pumps – design of high vacuum units – Ultra high vacuum units. Measurement of pressure – Pirani gauge – Penning gauge – Hot cathode ionization gauges – **UHV gauges***.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom

Books for study:

1. Electronics in Industry — G.M. Chute and R.D. Chute, McGraw Hill International (1995).
2. Electronic Systems and Instrumentation — R.W.Henry, Wiley & Sons Publishing (1978).
3. Digital Computer Electronics — Malvino, McGraw Hill Publishing (1992).

Book for Reference:

1. Instrumentation: Experimentation and Application — R.W.Perbwitt, S.W.Farads, Wiley Publishing (1962).
2. Scientific foundation of Vacuum Technology — S.Dushman, J.M.Lafferty, John Wiley (1962).
3. Hand book of Semiconductor Electronics — Lloyd. P. Hunter, McGraw Hill (1956).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**S**
CO 3	**S**	**H**	**S**	**S**	**H**
CO 4	**S**	**H**	**S**	**H**	**H**
S- Strong	**H-High**		**M-Medium**		**L - Low**

NON-MAJOR ELECTIVE PAPERS

(2 papers are to be chosen from the following 4 papers)

1. **Nanotechnology: Principles and Applications**
2. **Thin Film Physics, Plasma Physics and Crystal Growth**
3. Atmospheric Science
4. Biomedical Instrumentation

Course Code: 19PPH3N1

<table>
<tr><th colspan="2">Programme: 03</th><th colspan="3">M.Sc Physics</th></tr>
<tr><td colspan="2">Course Code: 19PPH3N1</td><td colspan="3">Non-Major Elective 1 - Nanotechnology Principles and Applications</td></tr>
<tr><td>Batch
2019-2020</td><td>Semester
III</td><td>Hours/Week
5</td><td>Total Hours
75</td><td>Credits
5</td></tr>
</table>

Course Objective

To impart knowledge on

i) To understand the nanomaterial and nanotechnology
ii) To know the different synthesis processes for making nanomaterials
iii) To know the characterization techniques available for nanomaterials
iv) To explore the nano-devices and various applications

Course Outcome (CO)

K1	**CO1**	Understand the basic concepts of nanoscience, physical principles of quantum confinement and classification of nanostructures.
K2	**CO2**	Know the synthesis methods of 0-D, 1-D, 2-D and 3-D nanomaterials and its own advantages.
K3	**CO3**	Know the various characterization methods to study material’s morphological, structural and optical properties.
K4	**CO4**	Gain knowledge in the applications of nanotechnology in the field of data storage, biology solar cell, sensor and rechargeable batteries.

UNIT I **15 hrs**

Physical concepts in Nanomaterials

Classification of nanomaterials – Quantum confinement in semiconductor nanostructures: quantum well, quantum wires and quantum dots: Electronic density of states, Surface to volume ratio versus shape, The quantum Hall effect - Resonant tunneling - Interband absorption in semiconductor nanostructures - Intraband absorption in semiconductor nanostructures - Light emission processes in nanostructures - The phonon bottleneck in quantum dots.

UNIT II **15 hrs**

Synthesis of Nanoscale materials and structures

Methods of making 0-D Nanomaterials:

Inert gas condensation, Inert gas expansion, Sonochemical processing, Spray pyrolysis - Sol-gel deposition and molecular self-assembly

Methods of making 1-D and 2-D Nanomaterials:

Foil beating – Electrodeposition – Physical Vapor Deposition (PVD) – Chemical Vapor Deposition (CVD)

Methods of making 3-D Nanomaterials:

Top down processes: milling and mechanical alloying

Methods of nanoprofiling:

Micromachining – Photolithography*

Course Code: 19PPH3N1

UNIT III **15 hrs**

Characterization of Nanomaterials

X-ray Diffraction - UV-Vis Spectrophotometer - Scanning Electron Microscope – Transmission Electron Microscope, HRTEM – Atomic Force Microscope – Scanning Tunneling Microscope – Laser Raman Spectrometer – X-ray Photoelectron Spectroscopy

UNIT IV **15 hrs**

Properties of Nanomaterials

Mechanical properties of nanostructured materials: nanodispersions, nanocrystalline solids - Thermal properties: melting point, thermal transport - Electrical properties – Magnetic properties – GMR - Optical properties - Surface plasmon resonance - photocatalytic properties

UNIT V **15 hrs**

Nanotechnology applications

Biosensors: Silicon nanowire biosensor, Cantilever biosensor-drug delivery-photovoltaics: dye sensitized solar cell, quantum dot sensitized solar cell – nanocatalysis - displays: QDLED, batteries – supercapacitors.

*** Self Study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for Study:

1.	Nanomaterials, Nanotechnologies and An Introduction for engineers and and Design Architects	Micheal F. Ashby, Paulo J. Ferreira, Daniel L. Schodek, (Unit I, II, III & IV), Elsevier Science (2009)
2.	Nanoscale Science and Technology	Robert Kelsall, Ian hamley, MarkGeoghegan, (Unit I, II,V), John Wiley & Sons, Ltd (2005).
3.	Nanostructures and Nanomaterials: Synthesis, Properties and Applications	Guozhong Cao, (Unit IV), Imperial College Press (2004).

Books for Reference:

1.	Nanoparticle Technology Handbook	Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Elsevier Science (2007).
2.	Handbook of Nanostructured nanotechnology	Hari Singh Nalwa, materials and Academic Press Vol (1- 5) (2000).

Course Code: 19PPH4N1

Mapping					
	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO 1	S	H	H	S	H
CO 2	H	S	S	H	H
CO 3	H	H	S	H	S
CO 4	S	H	H	S	H
S- Strong	H-High		M-Medium		L - Low

Course Code: 19PPH4N2

Programme code : 03		M.Sc Physics		
Course Code: 19PPH4N2		Non-Major Elective 2 : Thin Film Physics, Plasma Physics and Crystal Growth		
Batch 2018-2019	Semester IV	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to understand the
1. Preparation and characterization of thin films
2. Fundamentals of plasma Physics
3. Techniques of crystal growth

Course outcome (CO)

K1	**CO1**	Have knowledge on the mechanism and process for the synthesis and evolution of thin films
K2	**CO2**	Be able to understand the principles, advantages and disadvantages of different thin film deposition methods
K3	**CO3**	Be able to the fundamental plasma parameters (under what conditions an ionized gas can be treated as plasma) and to distinguish single particle approach and fluid approach
K4	**CO4**	Be able to understand the physical and chemical processes for the growth of crystals and the different growth techniques

UNIT I **15 hrs**

Methods of preparation of thin films

Physical Vapor Deposition- Basic vacuum systems- vacuum evaporation- sputtering- DC/RF sputtering- electron beam evaporation- **pulsed laser deposition***.

Chemical deposition – sol-gel methods spin coating- dip coating- spray pyrolysis- chemical bath deposition- atomic layer deposition

UNIT II **15 hrs**

Nucleation, Growth and Thickness measurements

Nucleation and growth

Thermodynamis of nucleation – nucleation theories- film growth –incorporation of defects, impurities etc., in thin film –deposition parameters and grain size.

Thickness measurements

Interferometry – Fringes of equal thickness (FET) – Fringes of equal chromatic order (FECO) – Step gauges - Ellipsometry – Stylus profilometry - Vibrating quartz crystal method - Gravimetric balance method

UNIT III **15 hrs**

Plasma state - Characterization

Occurrence of plasma in nature- definition of plasma –concept of temperature-Debye shielding –plasma parameters- criteria for plasma – single particle motion: uniform B field –uniform E and B fields- Gravitational field –**non uniform B field*** –curved B –magnetic mirrors

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Course Code: 19PPH4N2

UNIT IV **15 hrs**

Fluid theory and Application of Plasma

Derivation of fluid equation of motion - fluid drifts perpendicular to B- fluid drifts parallel to B **Application of Plasma Physics:** Production of nano particles by plasma-Plasma nitriding – Plasma sources for hospital waste-Plasma treatment of textiles.

UNIT V **15 hrs**

Crystal growth

Growth from liquid solution: Aqueous solution growth – Holden's rotary crystallizer- Mason jar method - temperature differential methods- chemical reactions – sol gel growth – liquid crystal (preliminary ideas only).

Hydrothermal growth: Modified Bridgemann hydrothermal autoclave- Morley hydrothermal autoclave – phase equilibria and solubility- kinetic quartz.

*** Self-study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Thin film fundamentals — A.Goswami New age international (P) Ltd., (2006).
2. Introduction to Plasma Physics and controlled fusion — Francis F.Chen, Plenum Press, New York (1984).
3. Plasma Sciences and the creation of wealth, — P.I. John, Tata McGraw Hill Publishing Company Limited (2005).
4. Growth of Crystal from liquids, — J.C.Brice Blackie & Sons Pub., (1986).

Books for Reference:

1. Hand book of thin film Technology — L.T. Meisssel and R.Glang McGraw Hill (1978).
2. Principles of Plasma Physics — Nichola A. Krall and Alvin W.Trivelpiece, McGraw Hill Publications (1982).
3. Thin Film Phenomena — K.L. Chopra, Robert E. Krieger Publishing Company (1979).
4. Materials Science of Thin Films — Milton Ohring, Academic Press (2001).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	H	S	H	
CO 2	S	H	H	S	S
CO 3	H	S	S	S	H
CO 4	S	H	H	H	S
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH54

Programme: 03		M.Sc Physics		
Non-Major Elective 3 -Atmospheric Science				
Batch 2019-2020	Semester	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to

1. study about atmospheric thermodynamics and radiation
2. impart knowledge on clouds and precipitation and Air pollution.
3. study about meteorological systems and global energy balance

Course Outcome (CO)

K1	**CO1**	Know the composition and structure of atmosphere.
K2	**CO2**	Describe atmospheric thermodynamics and radiations
K3	**CO3**	Able to interpret clouds and precipitation
K4	**CO4**	Deliver the meteorological systems and global energy balance and to calibrate air pollution

Unit I **15hrs**

Atmosphere

Origin and composition of the atmosphere, distribution of pressure and density, ionosphere, atmospheric electric field and magneto sphere, distribution of temperature and winds, measurement of temperature and humidity, measurement of wind and masses, measurement of precipitation, modern metrological instruments.

Unit II **15hrs**

Atmospheric Thermodynamics and Radiations

Gas laws and equation of state for a mixture of ideal gases, work, heat and First Law of thermodynamics, adiabatic processes, moist thermodynamics and latent heats, thermodynamic diagram, saturated adiabatic and pseudoadiabatic processes, stability criteria using parcel method, stability criteria using slice method, entrophy and second law of thermodynamics, Carnot cycle and Clausius Clapeyron equation, Black body radiation, absorption and emission of radiation by molecules, indirect estimate of solar irradiation at the top of the atmosphere, scattering of solar radiation.

Unit III **15hrs**

Clouds and Precipitation

Atmospheric Aerosols, Aerosol size and concentration, sources and sinks of atmospheric aerosol, Nucleation theory of water vapour condensation, cloud condensation nuclei, growth of cloud droplets in warm clouds by condensation, Grouth of cloud droplets by collision and coalescence, mechanism of cloud formation, types of clouds, cloud seeding, role of clouds and precipitation products in charge separation, mechanism of charge separation, circulation and vorticity, Kelvin's circulation theorem.

Unit IV **15hrs**

Meteorological Systems and Global energy balance

Air masses, warm front, cold front, stationary front, occluded fronts, monsoons, differential heating of Land and Sea, compressibility, rotation and moisture effects, tropical and oceanic convergent zones, monsoon disturbances, semi permanent monsoon systems over India, factors responsible for the formation of tropical cyclone, climatology of tropical cyclones, movement of tropical cyclones, life cycle of a tropical cyclones, tropical cyclone structures, thunderstorms, life cycle of thunderstorms, tornadoes, global energy balance requirement for the earth's atmosphere, energy processes in the upper atmosphere, weather forecasting and climate forecasting.

Unit V **15hrs**

Air pollution

Air pollution in perspective - The LOS Angeles Smog-Global and regional pollutants- The principal atmospheric polluants, effects of air pollution – health effect- effects on plants and animals, effects on materials and services, source of air pollution- identifying air pollution-Natural sources-Domestic sources-Commercial sources-Industrial sources-Agricultural sources-Transformation related sources, control of air pollution-Natural cleaning of the atmosphere-Air quality control, particle emission control, gas emission control, Nitrogen oxide emission control, Ambient air quality control by Dilution, Predictor air pollution concentration-Air pollution meteorology.

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment / Google Classroom.

Books for study:

1. Basics of Atmospheric science — A.Chandrasekar, PHI Learning Private Limited, New Delhi-110001 (2010).
2. Environment Science and Engineering — J.GlynnHenry,Gary, W.Heinke, PHI Learning private Limit, New Delhi (2009).

Books for reference:

1. Atmospheric Science-An Introductory Survey — J.Wallace, P.Hobbs, Elsevier, Second Edition (2006).
2. The atmosphere-An Introduction to Meteorology — Frederick K.Lutgens, Edward J. Tarbuck, PHI Learning Private Limited, New Delhi-01 (2010).
3. Air pollution and control — Minali Krishnan, K.V.S.G, Kaushal & Co, (1995).

Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	**S**	**H**	**H**	**S**	**H**
CO 2	**H**	**S**	**S**	**H**	**H**
CO 3	**H**	**H**	**S**	**H**	**S**
CO 4	**S**	**H**	**H**	**S**	**H**
S- Strong	**H-High**		**M-Medium**	**L – Low**	

Programme: 03		M.Sc Physics		
Non-Major Elective 4 - Biomedical Instrumentation				
Batch 2019-2020	Semester IV	Hours/Week 5	Total Hours 75	Credits 5

Course Objective

To enable the learners to

1. Impart knowledge on various biomedical instruments
2. understand the working of biomedical instruments

Course outcome (CO)

K1	**CO1**	Learn several signals that can be measured from the human body. Specific examples include temperature, electrical, and pressure signals.
K2	**CO2**	Understand theory and design on Measurement of blood flow and pressure.
K3	**CO3**	Understanding the problem and ability to identify the necessity of equipment to a specific problem.
K4	**CO4**	Study the designs of several instruments used to acquire signals from living systems. Integrate information learned about biomedical signals, sensors and instrumentation design.

UNIT I **15 hrs**

Bioelectric potential and transducers

Origin of bioelectric signals – Electrocardiogram – Electroencephalogram – Electromyogram – Physiological transducers – classifications – characteristics – variable resistance, capacitance, inductance transducers – LVDT – Piezoelectric transducers – pressure transducers – LVDT and strain gauge transducers – electrical resistance thermometer – Photoelectric transducers – Photovoltaic and Photoemissive cells – **Silicon diode detectors and diode arrays***

UNIT II **15 hrs**

Pulmonary function Analyzers

Ventilation, distribution and diffusion –Respiratory volumes and capacities– Basic Spirometer and Ultrasonic Spirometer.

Blood Gas Analyzers

Acid – Base balance, Blood pH measurements – electrodes for blood pH measurements – Effect of blood on electrodes – Buffer solutions. Measurement of blood pCO_2 - blood pO_2 measurements – A complete blood gas analyzer.

Oximeters

Principle of oximetry – invitro-oximetry and invivo-oximetry. Ear oximeter and pulse oximeter.

UNIT III **15 hrs**

Blood Cell Counters and Audiometer

Types of blood cells - Methods of cell counting- Automatic optical method - Electrical conductivity method - Coulter counter – Mechanism of hearing – Measurement of Sound – Basic audiometer – Hearing Aids – conventional and digital hearing aids.

Bio-medical Recorders
Electrocardiograph (ECG) – block diagram description of an ECG – ECG leads (basic concepts) – Microprocessor based ECG machines - Electroencephalograph (EEG) – block diagram description of an EEG – Computerized analysis of EEG.
Telemedicine
Telemedicine applications – Telemedicine concepts – essential parameters for telemedicine – block diagram explanation of a typical telemedicine system – **Concepts of Telemedicine technology***

UNIT IV **15 hrs**
Modern Imaging Systems
X-Rays: Nature of X-rays, properties and units of X-rays- X-ray machine – Visualization of X-rays: - X-ray Image Intensifier System – Basic Principle of X-ray Computed Tomography.

Magnetic Resonance Imaging
Principles of NMR imaging systems – Fourier transformation of the FID - Basic NMR components – block diagram explanation – biological effects of NMR imaging - Advantages of NMR imaging System.

Ultrasonic Imaging Systems
Principle of Ultrasonic waves – Generation and detection of Ultrasound – Medical ultrasound – ultrasonic imaging instrumentation.

UNIT V **15 hrs**
Electrical safety of medical instruments
Introduction – radiation safety instrumentation - physiological effects due to 50 Hz current passage – micro shock – macro shock – electrical accidents in hospitals – devices to protect against electrical hazards – hospital architecture.

*** Self study**

Teaching Methods: Power Point Presentation / Seminar / Discussion / Assignment/ Google Classroom.

Books for study:

1. Hand book of biomedical instrumentation	R.S Kandpur, Tata McGraw Hill Publishing Co (2014).
2. Biomedical Instrumentation	Dr.M.Arumugam, Anuradha, Agencies Publishers, Kumbhakonam (2010).

Book for reference:

1. Biomedical Instrumentation and Measurements	Leslie Crombwell, Fred.J.Weibell & Trich.A.Pfeiffer, Prentice Hall of India (2011).
2. Electronic Instrumentation	H.S.Kalsi, Tata Mc GrawHill Co (2013).

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Mapping					
	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**
CO 1	S	H	H	S	H
CO 2	H	S	H	H	H
CO 3	H	S	H	H	S
CO 4	S	H	S	H	H
S- Strong	**H-High**		**M-Medium**		**L - Low**

PPH59
ADVANCED LEARNER'S COURSE –
Advanced Experimental Techniques

Course Objective

To enable the learners to

1. Different types of surface, morphological and spectroscopic characterization techniques
2. Various types of magnetic and thermal analytic techniques

Unit I

Structural Characterization

Atomic Absorption Spectroscopy (AAS): Instrumentation - Sample preparation - Analysis – limitations. Inductively Coupled Plasma (ICP): Instrumentation and measurement techniques. Atomic Emission Spectroscope (AES): Instrumentation and measurement techniques.

Unit II

Spectroscopic Analysis

Infra Red (IR) – Fourier Transform Infra-Red (FTIR) – Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS) – X-ray Absorption (XPS) – Electron Spin Resonance (ESR) – Nuclear Magnetic Resonance (NMR)

Unit III

Morphological techniques

Confocal microscope - Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM – TEM - Selected Area Electron Diffraction (SAED) – Atomic Force Microscope (AFM)

Unit IV

Magnetic properties

Vibrating Magnetometer- Cyclic Voltametry-SQUID Magnetometer.

Unit V

Thermal analytical techniques

Thermo-gravimetric (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC) – Graphical analysis affecting various factors.

Books for study:

1. Characterization of Materials	John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992).
2. Instrumental Methods of Analysis	H. H. Willard, CBS Publishers (1991).
3. Instrumentation: Devices and Systems	C.S. Rangan, G.R. Sarma, Tata McGraw Hill Publishing (1997).

Books for Reference:

1. Fundamentals of Molecular Spectroscopy	Banewall, McGraw Hill Publishers (2017).
2. Spectroscopy	B.K. Sharma, GOEL Publishing House, Meerut (12th Edition 2007).