PG & RESEARCH DEPARTMENT OF PHYSICS

M.Sc. PHYSICS SYLLABUS

(For the Candidates to be admitted from the academic year 2022-2023 onwards)

POOMPUHAR COLLEGE (AUTONOMOUS)

(of the Tamil Nadu H.R.& C.E Admn. Dept)

MELAIYUR - 609 107

2022

POOMPUHAR COLLEGE (AUTONOMOUS)

OF THE TAMIL NADU HR & CE DEPARTMENT

MELAIYUR - 609 107

PG & RESEARCH DEPARTMENT OF PHYSICS

COURSE STRUCTURE FOR PG COURSE

(Applicable to the candidates admitted from the academic year 2022 – 2023 onwards)

SEMESTER	COURSE	HOURS	CREDI	EXAM. HOUR	MAX. MARKS		TOTAL
					CIA	EXT	
I	**Core Course-I** Classical mechanics	6	5	3	25	75	100
	Core Course-II Mathematical physics-I	6	4	3	25	75	100
	Core Course-III Electronics	6	4	3	25	75	100
	Core Course-IV Condensed matter physics-I	5	4	3	25	75	100
	Core Course-V Practical -General and electronics	5	4	4	40	60	100
	Human Rights	2	2	2	25	75	100
	Total	**30**	**23**	-	-	-	**600**
II	**Core Course-VI** Quantum mechanics	6	5	3	25	75	100
	Core Course-VII Mathematical physics-II	6	4	3	25	75	100
	Core Course-VIII Condensed matter physics-II	5	4	3	25	75	100
	Core Course-IX Practical - General	5	4	4	40	60	100
	Elective course –I (Numerical methods and C++ programming / solar energy utilization / laser physics and non linear optics)	5	4	3	25	75	100
	Open elective –I (Basis of renewable energy sources / Disaster management / communication physics)	3	3	3	25	75	100
	TOTAL	**30**	**24**	-	-	-	**600**
III	**Core Course-X** Electromagnetic theory	6	4	3	25	75	100
	Core Course XI Thermodynamics and statistical Mechanics	6	4	3	25	75	100
	Core Course-XII Practical Micro processor and C++	5	4	4	40	60	100
	Core Course-XIII Research Methodology	5	4	3	25	75	100
	Elective course –II (Micro processor and Microcontroller / Material physics and processing techniques / Bio physics)	5	4	3	25	75	100
	Open elective –II (spectroscopy and lasers / Nano materials and its Applications / Analog and digital electronics)	3	3	3	25	75	100
	TOTAL	**30**	**23**	-	-	-	**600**
IV	**Core course –XIV** Nuclear and Particle physics	6	4	3	25	75	100
	Core course-XV Spectroscopy	6	4	3	25	75	100
	Core course –XVI Practical Electronics	6	4	4	40	60	100
	Elective course-III (Nano technology and thin film physics /)	6	4	3	25	75	100
	Project Work	6	4	-	-	-	100
	TOTAL	**30**	**20**	-	-	-	**500**
	GRAND TOTAL	**120**	**90**				**2300**

Head of the Department **Principal**

Note:

Core Courses (include Theory & Project)

Number of Courses	16
Credit per Course	4 – 5
Total Credits	**70**

Elective Courses

Number of Courses	3
Credit per Course	4

Open Elective Courses

Number of Courses	2
Credit per Course	3

Human Rights Paper

Human Rights Paper	1
Credit for Human Rights Paper	2

	Internal	**External**
Theory	25	75
Practicals	40	60
Project		100

Passing Minimum in a Subject

CIA	50%	(13 marks)
UE	50%	(37 Marks)
	Total - 50 Marks	

PG & RESEARCH DEPARTMENT OF PHYSICS

(For the Candidates to be admitted from the academic year 2022-2023 onwards)

MINUTES

04.08.2022

The board of studies meeting in Physics (UG) was held on 04.08.2022 at 10.30 a.m. The following members were present.

S.No	Name, Designation and address	Members	Signature
1	Dr.P.Rajesh Assistant Professor & HOD Poompuhar College, Melaiyur	Chairman	
2	Dr.D.Govindarajan Professor Annamalai University, Chidambaram	VC Nominee member	
3	Dr.C.Ramachandra Raja Associatet Professor Govt. Arts College (M) Kumbakonam	Academic Council Nominee Member	
3	Dr.M.Senthilkumar Assistant Professor Govt. Arts College (M) Kumbakonam	Alumni Member	
4	Dr.T.Mohamed Ali Assistant Professor Poompuhar College, Melaiyur	Member	
5	Mrs.S.Sathya Assistant Professor (SF) Poompuhar College, Melaiyur	Member	
6	Dr.J.Vijayapriya Assistant Professor (SF) Poompuhar College, Melaiyur	Member	
7	Miss. Renuga Assistant Professor (SF) Poompuhar College, Melaiyur	Member	

PG & RESEARCH DEPARTMENT OF PHYSICS

(For the Candidates to be admitted from the academic year 2022-2023 onwards)

RESOLUTIONS

05.08.2022

The following Resolutions have been passed unanimously

1. Resolved to incorporate all the suggestions given by board members.
2. The board scrutinized the regulations of 2022 -2023, programme structure and Scheme of Examinations for M.Sc., Physics programme and approved the same.
3. The board scrutinized the draft syllabus for each course submitted by the members. After incorporating the suggestions made by the members, the board approved the syllabi for M.Sc. Physics which will be introduced from 2022 – 23 onwards.
4. The board discussed the pattern of question papers to be followed in each year for the End Semester Examinations and approved the same.

S.No	Name, Designation and address	Members	Signature
1	Dr.P.Rajesh Assistant Professor & HOD Poompuhar College, Melaiyur	Chairman	
2	Dr.D.Govindarajan Professor Annamalai University, Chidambaram	VC Nominee member	
3	Dr.C.Ramachandra Raja Associatet Professor Govt. Arts College (M) Kumbakonam	Academic Council Nominee Member	
3	Dr.M.Senthilkumar Assistant Professor Govt. Arts College (M) Kumbakonam	Alumni Member	
4	Dr.T.Mohamed Ali Assistant Professor Poompuhar College, Melaiyur	Member	
5	Mrs.S.Sathya Assistant Professor (SF) Poompuhar College, Melaiyur	Member	
6	Dr.J.Vijayapriya Assistant Professor (SF) Poompuhar College, Melaiyur	Member	
7	Miss. Renuga Assistant Professor (SF) Poompuhar College, Melaiyur	Member	

Date : 05.08.2022 **Head of the Department**

Place: Melaiyur

PG & RESEARCH DEPARTMENT OF PHYSICS

(For the Candidates to be admitted from the academic year 2022-2023 onwards)

RESOLUTIONS

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The following Resolutions have been passed unanimously

1. Resolved to incorporate all the suggestions given by board members.
2. The board scrutinized the regulations of 2022 -2023, programme structure and Scheme of Examinations for M.Sc., Physics programme and approved the same.
3. The board scrutinized the draft syllabus for each course submitted by the members. After incorporating the suggestions made by the members, the board approved the syllabi for M.Sc. Physics which will be introduced from 2022 – 23 onwards.
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PG & Research Department of Physics

Learning Objectives, Course Outcome and Course Outcome Mapping are included in every subjects of PG and UG Physics syllabus.

- ✓ Learning Objective for units of Subject covers from LO1 to LO5.
- ✓ Course Outcome for units of Subject takes CO1 to CO5
- ✓ Course Outcome Mapping for each subject gives correlation between Programme Outcome versus Course Outcome.

Programme Outcomes (POs)

- **PO1: Disciplinary Knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of a postgraduate programme of study.
- **PO2 -** Analytical and Technical Skills: Ability to handle/use appropriate tools/techniques.
- **PO3** – Critical thinking and Problem Solving: Critically analyse problems and to arrive viable conclusions
- **PO4** – Environment and Society: Analyze the impact of scientific advances on the environment and society.
- **PO5** – Lifelong learning: Ability to engage in lifelong learning in the discipline.

Programme Specific Outcomes (PSOs):

- **PSO1: Knowledge:** Attain adequate knowledge in Physics concepts in subjects like Mathematical Physics, Classical Mechanics, and Quantum Mechanics etc. to gain the ability to understand and deal with abstract concepts.
- **PSO2: Entrepreneur:** Produce effective entrepreneurs by enhancing their critical thinking, problem solving, decision making, technical skill and leadership skill in order to facilitate start-ups and high potential organizations.
- **PSO3: Research and Development:** Design and implement HR systems and practices grounded in researches that comply with employment laws, leading the organization towards growth and development.
- **PSO4: Contribution to Business World:** To create employable, ethical and innovative professionals to sustain in the dynamic business world.
- **PSO5: Contribution to the Society:** To contribute the development of the society by collaborating with stakeholders for mutual benefit.

HOD **PRINCIPAL**

SEMESTER: I	TITLE: CLASSICAL MECHANICS AND RELATIVITY	CREDITS: 5
PART: CORE COURSE I	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To make learning of Classical Mechanics interesting and to teach the Lagrangian and Hamiltonian formalisms and their applications.
LO2	To study the kinematics of the rigid body through Euler's equations
LO3	To study the theory of Hamilton Jacobi theory and central force problem
LO4	To teach the theory of small oscillations and vibrational modes of molecules and to reate an understanding of the principles of Nonlinear dynamics and classical chaos.
LO5	To understand relativity and its consequences

Unit I: Fundamental Principles and Lagrangian Formulation

Mechanics of a particle and system of particles - Conservation laws - constraints -Generalized coordinates -Principle of Virtual work- D'Alembert's principle and Lagrange's equation -Applications of Lagrange's equation-Atwood's Machine, simple pendulum, Linear Harmonic Oscillator- Hamilton's Principle - Lagrange's equation of motion -conservation theorems and symmetry properties - Motion under central force: General features - Geo stationary Satellites-Eccentricity of orbit of satellites - Escape Velocity.

Unit II: Rigid body dynamics and theory of small oscillations

Rigid Body Dynamics : Euler angles - Moments and products of inertia -Euler's equations - Symmetrical top.

Oscillatory Motion : Theory of small oscillations - Normal modes and frequencies - Linear triatomic molecule, Wave motion - wave equation - Phase velocity - Group Velocity - dispersion.

Unit III: Hamilton's Formulation

Hamilton's canonical equations of motion - Hamilton's equations from variational principle - Applications of Hamilton's equation- simple pendulum,compound pendulum,Linear Harmonic oscillator- principle of least action - Canonical transformations - Poisson brackets - Hamilton - Jacobi method - Action and angle variables - Kepler's problem in action - angle variables.

Unit IV: Nonlinear Dynamics

Linear and nonlinear oscillators - Phase trajectories - Period doubling phenomenon in Duffing oscillator. **Soliton:** Linear and nonlinear waves - Solitary Waves - KdV equation - Numerical experiments of Kruskal and Zabusky - Solitons.

Unit V: Relativity

Basic ideas of special theory of relativity -energy momentum four vector - Minkowski's four dimensional space - Lorentz transformation as rotation in Minkowski's space - Compositions of L.T about two orthogonal directions - Thomas precession – Invariance of Maxwell's equations under Lorentz transformation - Elements of general theory of relativity.

Course Outcomes:

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

CO1	have depth knowledge about Lagrangian and Hamiltonian formulations and solve problems using those formulations.
CO2	have knowledge about fundamentals of rigid body motion and explain Moment of inertia tensor and Euler's equations of motion and will also be able to solve problems on force free motion of a rigid body and symmetrical top.
CO3	apply Hamilton's characteristic function to solve problems. Understand Action Angle variables and solve one degree of freedom and Kepler's problem.
CO4	acquire knowledge about oscillatory motion and stability of oscillatory motion. understand the linear and nonlinear systems and basics of Chaos.
CO5	understand the applications relativistic mechanics and its consequences.

Text Books:

1. G. Aruldhas, *Classical Mechanics* - PHI Learning Private Limited, New Delhi. (2015).
2. H. Goldstein, C. Poole and J. Safko, *Classical Mechanics* - Pearson Education Asia New Delhi, Third Edition. (2002).
3. S. L. Gutpa, V. Kumar and H.V. Sharma, Pragati Prakashan, *Classical Mechanics* - Meerut. (2016)
4. M. Lakshmanan, and S.Rajasekar, *Nonlinear Dynamics - Integrability, Chaos and*

Supplementary Readings:

1. S.N. Biswas, *Classical Mechanics*, Books and Allied Ltd., Kolkata. (1998).
2. Upadhyaya, *Classical Mechanics*, Himalaya Publishing Co., New Delhi. (1999)
3. L.D. Landau and E.M. Lifshitz, *Mechanics*, Pergomon Press, Oxford. (1969).
4. J.L. Synge and B.A Griffith, *Principles of Classical Mechanics* Mc.Graw-Hill, NewYork. (1949).
5. R.G.Takwale and P.S.Puranik, *Introduction to Classical Mechanics,* Tata Mc Graw Hill, New Delhi. (1989).
6. Dr.J.C.Upadhayaya ,*Classical mechanics* ,Himalaya publishing house Jan 2019

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	2	2	2
CO2	2	2	2	2	2
CO3	2	2	2	2	2
CO4	2	2	2	2	2
CO5	3	2	2	3	3

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SEMESTER: I	TITLE: MATHEMATICAL PHYSICS-I	CREDITS: 4
PART: CORE COURSE II	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To create a basic knowledge in mathematical physics
LO2	To develop expertise in mathematical techniques required in physics.
LO3	To enhance problem solving skills.
LO4	To enable students to formulate, interpret and draw inferences from mathematical solutions
LO5	To understand the problems in complex variable

Unit I: Introduction to Vector Algebra

Concept of gradient –gradient of scalar field –Line surface and volume integrals-Divergence of a vector function-Curl of a vector function – Physical significance –vector identities-guass divergence theorem-stokes theorem-Green theorem.

Unit II: Vector Analysis

Orthogonal curvilinear co ordinates –Expression for gradient ,curl and laplacian in cylindrical and spherical co ordinates(theory) linear dependent and independent set of vectors-inner product-Schmidt's orthogonalisation process

Unit III: Matrices

Types of Matrices and their properties, Rank of a Matrix, Eigenvalue Equations and their solutions, Theorems on Matrices; Diagonalisation and Diagonalisation of different matrices; Cayley-Hamilton's theorem; Problems.

Unit IV: Tensor Analysis

Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Summation convention- Symmetry and Anti-symmetry Tensor – Contraction and direct product – Quotient rule- Pseudo tensors, Levi-Civita Symbol - Dual tensors, irreducible tensors-Metric tensors-Christoffel symbols – Geodesics.

Unit V: Complex Variable

Functions of complex variable-Analytic functions-Cauchy- Riemann equations- integration in the Complex plane-Cauchy's theorem- Cauchy's integral formula-Taylor and Laurent expansions- Singular Points- Cauchy's residue theorem - poles - evaluation of residues -evaluation of definite integrals.

Course Outcomes

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

CO1	create a basic knowledge in mathematical physics
CO2	develop expertise in mathematical techniques required in physics.
CO3	enhance problem solving skills.
CO4	enable students to formulate, interpret and draw inferences from mathematical solutions
CO5	understand the problems in complex variable

Text Books:

1. B.D. Gupta, *Mathematical Physics,* Vikas Publishing House Pvt. Ltd (1995).
2. B.S.Rajput, *Mathematical Physics*, 20th Edition, Pragati Prakashan (2008).
3. H.K. Dass and Rama Verma, *Mathematical Physics*, S.Chand and Company Ltd (2010).
4. P.K. Chattopadhyay, *Mathematical physics*, Wiley Eastern Limited (1990).

Supplementary Readings:

5. Charlie Harper, *Introduction to Mathematical physics*, Prentice Hall of India Pvt.Ltd (1993).
6. L.A. Pipes and L.R. Havevill, *Applied Mathematics for Engineers and Physicists,* McGraw Hill Publications Co., 3rd Edition (1971).
7. Murray R. Spigel,*Theory and Problems of Laplace Transforms,* Schaum's outline series, McGraw Hill (1986).
8. A.W. Joshi , *Matrices and Tensors in Physics,* Wiley Eastern limited (1975).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	2	3	2	3
CO2	2	2	3	2	2
CO3	2	2	3	2	2
CO4	2	2	2	2	2
CO5	3	2	3	3	3

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SEMESTER: I	TITLE: ELECTRONICS	CREDITS: 4
PART: CORE COURSE III	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To create a depth knowledge in power electronics
LO2	To develop expertise in techniques required in physics.
LO3	To enhance problem solving skills.
LO4	To enable students gained theoretical knowledge in classroom can be experimented in practicals
LO5	To deveplope knowage about fabrication of ics and logical applications

Unit I: Power Electronics & Power Diodes

Principle –Types-classification:Rectifiers-controlled rectifiers,A.C- voltage controller-choppers-Inverters-Static switches-Power diodes-Types of power diode-MCT(Mos controlled thyristor)-Opto coupler-types-LED photo diode opto coupler-LED photo transistor optocoupler.

Unit II:Operational Amplifier

Inverting, Non- inverting Amplifiers- circuits – Adder- Subtractor-Differentiator- Integrator-Schmitt Trigger – Triangular wave generator – Sine wave generator –Wein bridge oscillator-Phase shift oscillator.

Unit III: Semicondutor Memories

Classification of memories and sequential memory – Static Shift Register and Dynamic Shift Register, Memory - principle, block diagram and operation. Programmable Logic Array (PLA) - Operation, Internal Architecture. Charge Couple Device (CCD) - Principle, Construction, Working and Data transfer mechanism

Unit IV: Fabrication of ICs and Logical Applications

Basic monolithic ICs-Epitaxial growth-Masking-Etching-Impurity-Diffusion-Fabricating monolithic resistors,diodes,transistors,capacitors-circuit layout-contacts and inter connections - Half adder and full adder,half subtractor and full subtractor,digital comparator,multiplexer and de-multiplexer-Decoder and encoder.

Unit-V: Nano Electronics

Introduction-Physical properties of nano scale electronics materials –Energy sub bands and density of states in a quantum wire-Ballistic Transport-Silicon nano transistor-Carbon nano tubes for nano devices-CNT transistor- High electron mobility-Transistor using hetero junction.

Course outcomes

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

CO1	understand the principles, working of semiconductor devices and diodes.
CO2	study the various classifications and applications of semiconductor memories
CO3	study the applications of operational amplifier.
CO4	highlight the concept of IC circuits and IC 555 timer.
CO5	understand basics idea about the IC's

Text Books:

1. Satnam P.Mathur, *Electronic Devices - Applications and Integrated Circuits,* John Wiley and Sons. (1986).
2. V.K.Mehta, ,*Principles of Electronics*- 6th Revised Edition, S.Chand and Company. (2001).
3. J. Millman, C. Halkias and C.D. Parikh, *Integrated Electronics, Analog and Digital Circuits and Systems TMGH.* (2010).
4. D. C. Dube, *Electronics circuits and analysis* – 2nd Edition, Narosa (2013).
5. Bhotkar ,*Integrated Circuits*. Khanna Publishers , (2010).
6. B.L.Theraja , *Basic Electronic*,S.Chand & company ltd(2007)
7. Gupta and Kumar, *Handbook of Electronics*- Pragati Prakashan-34th edition (2007).
8. D.Chattopadhyay and P.C. Rakshit, *Electronics-Fundamentals and Applications,* New Age International Publications, New Delhi. (2010).

Supplementary Readings:

1. T.F. Schubert and E.M.Kim, "*Active and Nonlinear Electronics*", John Wiley Sons, New York. (1996)
2. L.FIoyd, Electronic Devices, "*Pearson Education*" New York. (2004)
3. A. Mottershed, *Semiconductor Devices and Applications*, Prentice Hall India Learning Private Limited.(1979)
4. Ben.G.Streefman, *Solid state electronic devices*, Printice Hall, Englewood Cliffs, NJ. (1999).
5. Albert Malvino and David J Bates, *Electronic Principles*- 7 th Edition, McGraw Hill. (2007).
6. David A. Bell , *Electronic Devices and Circuits*, 4th Edition, Prentice Hall. (2007).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	2
CO2	2	3	2	2	3
CO3	3	2	2	2	3
CO4	2	2	3	2	2
CO5	2	2	2	2	2

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SEMESTER: I	TITLE: CONDENSED MATTER PHYSICS – I	CREDITS: 4
PART: CORE COURSE IV	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To give strong foundation in the conceptual understanding of the physical properties of crystals.
LO2	To make learning of Theory of Electrons and Dielectric Properties of Solids
LO3	To study the Theory of Ferroelectrics and Piezo Electrics
LO4	To create an understanding on the principles of Magnetic Properties of Materials
LO5	To develop analytical thinking to understand the phenomenon of optical properties of solids thereby equip students to pursue higher learning confidently.

Unit 1: Crystal Lattice and Bonding

Lattice representation - Simple symmetry operations - Bravais Lattices, Unit cell, Wigner - Seitz cell - Miller planes and spacing - Characteristics of cubic cells -

Crystal Binding*:* Interactions in inert gas crystals and cohesive energy – Lennard – Jones potential - Interactions in ionic crystals and Madelung energy - Covalent bonding – Heitler – London Theory – Hydrogen bonding – metallic bonding.

Unit 2: Diffraction of Waves and Particles By Crystals

X-rays and their generation - Moseley's law – Absorption of X-rays (Classical theory) – Absorption Edge – X-ray diffraction – The Laue equations – Equivalence of Bragg and Laue equations – Interpretation of Bragg equation – Ewald construction - Reciprocal lattice –Reciprocal lattice to SC, BCC and FCC crystals- Importance properties of the Reciprocal lattice – Diffraction Intensity -

Unit 3: Crystal Imperfections and Ordered Phases of Matter

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polorans – Excitons. Ordered phases of matter: Translational and orientation order - Kinds of liquid crystalline order -Quasi crystals - Superfluidity.

Unit 4: Lattice Dynamics

Theory of elastic vibrations in mono and diatomic lattices - Phonons – Dispersion relations - Phonon momentum - Heat Capacity: Specific heat capacity of solids – Dulong and Petit's law - Vibrational modes - Einstein model -Density of modes in one and three dimensions - Debye Model of heat capacity.

Unit 5: Theory of Electrons

Energy levels and Fermi-Dirac distribution for a free electron gas – Periodic boundary condition and free electron gas in three dimensions – Heat capacity of the electron gas – Ohm's law,– Hall effect and magnetoresistance – Wiedemann – Franz law- Bloch functions -Bloch theorem - Motion of an electron in a periodic potential – Kronig – Penney model -Approximate solution near a zone boundary .

Course outcomes

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

CO1	Give strong foundation in the conceptual understanding of the physical properties of crystals.
CO2	Have learning of Theory of Electrons and Dielectric Properties of Solids
CO3	Understand the Theory of Ferroelectrics and Piezo Electrics
CO4	Learn the principles of Magnetic Properties of Materials
CO5	Learn the hall effect and applications

Text books:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India Pvt. Ltd. New Delhi, 2004.
2. Rita John, Solid State Physics, Tata Mc Graw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid-State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid State Physics – Principles and Applications, Pearson, 1999.

Supplementary Readings:

1. M.A. Wahab, Solid State Physics, structure and properties of the materials. Narosa, New Delhi, 1999.
2. M.Tinkham, Introduction to Superconductivity, Tata McGraw Hill, New Delhi, 1996.
3. A.J. Dekker, Electrical Engineering Materials, Prentice Hall of India, 1975.
4. Kwan Chi Kao, Dielectric Phenomena in solids with emphasis on physical concepts of Electronic processes, Elsevier Academic press, 2004.

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	3	2	2	2	3
CO3	3	2	3	2	3
CO4	3	2	2	2	2
CO5	3	2	2	2	3

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SEMESTER: I	TITLE: PRACTICAL – I (GENERAL AND ELECTRONICS I)	CREDITS: 4
PART: CORE COURSE V	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To make the students to understand experimental physics
LO2	To apply the theoretical knowledge for developing new devices
LO3	To study the aspects related to the application side of the experiments
LO4	To understand the usage of basic laws and theories to determine various properties of the materials given
LO5	To develop skills

LIST OF EXPERIMENTS

(Any Twelve Experiments - Six experiments from each part)

A. General Experiments

1.Determination of q, n, σ by elliptical fringes method
2.Determination of Stefan's constant
3.Determination of bulk modulus of a liquid by ultrasonic wave propagation
4.Determination of Rydberg's constant
5.Study of Hall effect in a semiconductor
6..Determination of dielectric constant at high frequency by Lecher wire
7.Michelson interferometer — Determination of wavelength of monochromatic source.
8.Determination of wavelength of monochromatic source using biprism
9.Charge of an electron by spectrometer
10. Polarization of light — Verification of Malus law and Brewster angle of glass
11.BH loop - Energy loss of a magnetic material - Anchor ring using B.G./CRO
12.Determination of e/m of an electron by Thomson method
13.Verification of Hartmann's formula using spectrometer

B. Electronics Experiments

1.Construction of FET Amplifier CS
2.Astable and monostable multivibrators using IC555
3.Characteristics of UJT
4.Characteristics of SCR
5.Design and study of Wein bridge oscillator using op-amp
6.Design and study of square and triangular waves generators using op-amp
7.Construction of FET amplifier CD
8.Characteristics of FET
9.Up/down counter using mod 10
10. Operation of shift register using serial-in serial-out, serial-in parallel-out and parallel-in serial- out

Course outcomes

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

CO1	make the students to understand experimental physics
CO2	apply the theoretical knowledge for developing new devices
CO3	study the aspects related to the application side of the experiments
CO4	understand the usage of basic laws and theories to determine various properties of the materials given
CO5	develop skills in electronics

Text books:

1. C.C. Ouseph, U.J.Rao, V. Vijayendran, *Practical Physics and electronic*, Ananda book Depot, Chennai (2018).

2. M.N.Srinivasan, S.Balasubramanian ,R.Ranganathan, *A Text book of Pratical Physics*, Sultan Chand & Sons, New Delhi.(2015)

Supplementary Readings:

1. Samir Kumar Ghosh, *A Text book of Advanced Pratical Physics*, NCBA, Kolkatta.(2000).
2. D. Chattopadyay, P.C Rakshit, An Advanced Course in Pratical Physics, NCBA, Kolkatta.(2000).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	2
CO2	3	3	3	2	3
CO3	2	3	3	2	2
CO4	3	3	3	2	3
CO5	2	3	3	2	2

SEMESTER: II	TITLE: QUANTUM MECHANICS	CREDITS: 6
PART: CORE COURSE VI	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To introduce the basic postulates of quantum mechanics.
LO2	To make the student to understand exactly solvable systems.
LO3	To elucidate the aspects of time – independent and time-dependent perturbation theories.
LO4	To introduce the concepts of angular momentum and identical particles.
LO5	To make the students to understand relativistic quantum mechanics.

Unit I : Schrodinger Equation and General Formulation

Schrodinger Equation -Physical meaning and properties of the wave function -basic postulates of quantum mechanics - Expectation values and Ehrenfest's theorem - Hermitian operators and their properties - Commutation relations - Uncertainty relation - Bra and ket vectors - Hilbert space - Schrodinger, Heisenberg and interaction pictures.

Unit II: Exactly Solvable systems

Linear harmonic oscillator –Asymptotic solution significance- Solving the -one dimensional Schrodinger equation - Abstract operator method - Particle in a box -Square well potential - Rectangular barrier potential –Transmission probability –Reflection probability-Rigid rotator - Hydrogen atom.-Polar wave equation-Hydrogen like wave function-Applications

Unit III: Approximation Methods

Time independent perturbation theory: Non-degenerate and degenerate perturbation theories – Evaluation of first and second order wave functions- Stark effect – Eigen functions and Eigen values- WKB Approximation - Application to tunneling problem and quantization rules.

Time dependent perturbation theory: Harmonic Perturbation - Transition probability-sudden Approximation.

Unit IV: Scattering Theory and Angular Momentum

Scattering theory: Scattering amplitude and cross section -Green function approach- Born Approximation - Partial wave analysis.

Angular momentum: Matrix Representation of J-Spin angular momentum -Eigenvalues -Addition of angular momenta -Clebsch- Gordan coefficients {basic ideas only).

Unit V: Relativistic Quantum Mechanics

Klein -Gordon equation for a free particle and in an electromagnetic field - Dirac equation for a free particle - Charge and current densities - Dirac matrices - Plane wave solution -Negative energy states - Zitterbewegung -Spin angular momentum -Spin -orbit-coupling.

Course Outcome:

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

CO1	Recognize the concept of quantum mechanical tool
CO2	Describe the application of Schrodinger's equation to exactly solvable problems
CO3	Analyse the approximations of quantum mechanical problems.
CO4	Represent various momentum tools
CO5	Understand and apply the Relativistic quantum field.

Text Books:

1. Schiff, *Quantum Mechanics* Tata McGraw Hill, New Oeibi, (1958).
2. V. Devanathan, *Quantum Mechanics,* Naroso Publishing House.(2005)
3. P.M. Mathews and K. Venkatesan, *A Text Book of-Quantum Mechanics,*Tata McGraw Hill, New Delhi, (1987).
4. V.K. Thankappan, *Quantum Mechanics* , Wiiey-Eastern, New Delhi (1985).

Supplementary Readings:

1. A. K. Ghatak and Lokanathan, *Quantum Mechanics-Theory and applications,*Macmillan India Ltd Publication, Fifth Edition (2015).
2. Leonard I. Schiff, *Quantum Mechanics,McGraw*, Hill International Publication, Third Edition, (1968).
3. V. K. Thankappan, *Quantum Mechanics* , New Age International (P) Ltd. Publication, Second Edition (2003).
4. E. Merzbacher, *Quantum Mechanics*, John Wiley Interscience Publications, Third Edition (2011).
5. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, *Quantum Mechanics (Vol .I)* -, JohnWiley Interscience Publications, First Edition (1991).
6. Pauling & Wilson, *Quantum Mechanics*, Dover Publications, New Edition (1985).
7. R. Shankar, *Principle of Quantum Mechanics* - Plenum US Publication, Second Edition (1994).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	3	2	3	2	3
CO3	3	2	2	2	3
CO4	2	2	2	2	2
CO5	3	2	2	2	3

SEMESTER: II	TITLE: MATHEMATICAL PHYSICS II	CREDITS: 4
PART: CORE COURSE VII	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To make the students the understand partial differential equations in physics problems.
LO2	To make the student in gaining knowledge of complex variable.
LO3	To involve the student to learn special functions.
LO4	To educate the students to develop the understanding of integral transforms.
LO5	To introduce the group theory

Unit I: Differential Equations

Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods – extended power series method for indicial equations.

Unit II: Special Functions – I

Gamma and Beta function- Legendre's differential equation: Legendre polynomials – Generating functions – Recurrence relation – Rodrigue's formula – Orthogonality; Bessel's differential equation: Bessel polynomials – Generating functions – Recurrence relation –Rodrigue's formula – Orthogonality.

Unit III: Special Functions – II

Hermite differential equation – Generating functions – Hermite polynomials – Recurrence relations – Rodrigue's formula – Orthogonality: Laguerre differential equations – Generating functions – Laguerre polynomials – Recurrence relation – Rodrigue's formula –Orthogonality.

Unit IV: Partial Differential Equations

Solution of Laplace Differential Equation – Two dimensional flow of heat in 13artesian and cylindrical co-ordinates. Solution of heat flow equation in one dimension – Solution of wave equation – Transvers e vibrations of a stretched string (Theory).

Unit V: Integral Transforms

Fourier transforms – cosine and sine transforms – Linearity theorem – Parseval's theorem – solution of differential equation. Laplace transforms – Definition – Linearity, shifting and change of scale properties. Inverse Laplace transforms – Definition – Problems – Solution of differential equation (problems using the above methods).

Unit V: Group Theory

Definition – Subgroups – Cyclic groups and abelian groups – Homomorphism and isomorphism of groups – Classes – Symmetry operations and symmetry elements – Representations of groups –Reducible and irreducible representations – Character tables for simple molecular types (C_{2v} and C_{3v} point group molecules).

Course Outcome:

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

CO1	Apply Partial Differential equation to solve various physics problems.
CO2	Solve problems using complex variable method.
CO3	Evaluate problems using Special functions
CO4	Solve problems using Fourier series and Fourier transforms.
CO5	Analyse problems using Probability theory.

Text Book:

1. B.D. Gupta, *Mathematical physics* , Vikas Publishing House, Pvt Ltd, First Reprint (2015).
2. B.S. Rajput, *Mathematical Physics,* Pragati Prakashan, 19th Edition. (2007).
3. Sathyaprakash, *Mathematical Physics,* Sultan Chand & Sons, 6th edition (2014).

Supplement Readings:

1. R.K.Gupta & H.C. Sharma, *Mathematical Physics* –Meenakshi Prakashan Meerut, (1989).
2. A.B. Gupta, *Fundamentals of Mathematical Physics* – Books and Allied (p) Ltd, Kolkata, 3rd Edition. (2010).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	2	2
CO2	3	3	3	2	2
CO3	3	3	3	2	2
CO4	3	2	3	2	2
CO5	3	2	3	3	3

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SEMESTER: II	TITLE: CONDENSED MATTER PHYSICS – II	CREDITS: 4
PART: CORE COURSE VIII	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To give strong foundation in the conceptual understanding of the physical properties of crystals.
LO2	To make learning of Theory of Electrons and Dielectric Properties of Solids
LO3	To study the Theory of Ferroelectrics and Piezo Electrics
LO4	To create an understanding on the principles of Magnetic Properties of Materials
LO5	To develop analytical thinking to understand the nano particles.

Unit I: Theory of Dielectrics

Dipole moment – Polarization – The electric field of a dipole – Local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – Ionic polarizabilities - Orientational polarizabilities - The polarizability catastrophe - Dipole orientation in solids - Dipole relaxation and dielectric losses – Debye Relaxation time - Relaxation in solids.

Unit II: Theory of Ferroelectrics And Piezo Electrics

Ferroelectric Crystals – Classifications of Ferroelectric crystals - Dipole theory of ferroelectricity – Landau Theory of the phase transition – Second order Transition – First Order Transition - Ferroelectric Transition - – Antiferroelectricity - Ferroelectric domains – Ferroelectric domain wall motion –Piezoelectricity - Phenomenological Approach to Piezoelectric Effects - Piezoelectric Parameters and Their Measurements - Piezoelectric Materials.

Unit III: Magnetic Properties of Materials

Terms and definitions used in magnetism – Classification of magnetic materials – Atomic theory of magnetism – The quantum numbers- The origin of permanent magnetic moments –Langevin's classical theory of diamagnetism – Sources of paramagnetism – Langevin's classical theory of paramagnetism – Quantum theory of paramagnetism – Paramagnetism of free electrons - Ferromagnetism – The Weiss molecular field – Ferromagnetic domains -Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

Unit IV: Superconductivity

Occurence of super conductivity - Destruction of super conductivity by magnetic fields - Meissner Effect – Type I and Type II Super conductors - Heat Capacity - Energy gap - Thermodynamics of the superconducting transition - London equation - Coherence Length - BCS theory of superconductivity, BCS ground state.

Unit V Crystal growth

Nucleation-Different kinds of nucleation – concept of formation of critical nucleus-classical theory of nucleation –Spherical and cylindrical nucleus-growth techniques:Melt growth – Bridgemann technique-Czochralski technique-advantages and disadvantages.

Course Outcome:

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

CO1	Give strong foundation in the conceptual understanding of the physical properties of crystals.
CO2	Have learning of Theory of Electrons and Dielectric Properties of Solids
CO3	Understand the Theory of Ferroelectrics and Piezo Electrics
CO4	Learn the principles of Magnetic Properties of Materials
CO5	Know about nano particles and their applications.

Text Books:

1. Charles Kittel, *Introduction to Solid State Physics*, 7th Edition, Wiley India Pvt. Ltd. , New Delhi (2004).
2. Rita John, *Solid State Physics*, Tata Mc Graw Hill Publications (2014).
3. M. A. Wahab, *Solid State Physics*, Structure and Properties of Materials. Narosa, New Delhi (1999).
4. J.D. Patterson, B.C. Bailey , *Solid-State Physics: Introduction to the Theory,* Springer Publications (2007).
5. M. Ali Omar, *Elementary Solid State Physics*, Principles and Applications, Pearson (1999).

Supplement Readings:

1. J. Blakemore, *Solid State Physics*, 2nd Edition, W. B. Saunders Co, Philadelphia, (1974).
2. C. M. Kachhava, *Solid State Physics*, Tata Mcgraw Hill, New Delhi (1990).
3. N. W. Aschroft and N. D., Mermin, *Solid State Physics*, Rhinehart and Winton, New York. (1976).
4. M. Tinkham, *Introduction to Superconductivity*, Tata Mcgraw Hill, New Delhi (1996).
5. K.K.Chattopadhyay, A.N.Banerjee, *Introduction to Nanoscience and Nanotechnolog*, PHI Learning private Ltd., Delhi (2014).
6. A. J. Dekker, *Electrical Engineering Materials*, Prentice Hall of India (1975).
7. S.O. Pillai, *Problems and Solutions in Solid State Physics*, New Age international Publishers, New Delhi (1994).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	2	3	2	3	2
CO3	2	2	2	3	2
CO4	2	2	2	3	2
CO5	3	3	2		

SEMESTER: II	TITLE: PRACTICAL – II (GENERAL AND ELECTRONICS II)	CREDITS: 4
PART: CORE COURSE IX	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To make the students to understand experimental physics
LO2	To apply the theoretical knowledge for developing new devices
LO3	To study the aspects related to the application side of the experiments
LO4	To understand the usage of basic laws and theories to determine various properties of the materials given
LO5	To develop skills

LIST OF EXPERIMENTS

(Any Twelve Experiments - Six experiments from each part)

(General and Electronics)

A. General Experiments

1. Determination of q, n, σ by hyperbolic fringes method
2. Determination of thermal conductivity of a good conductor - Forbe's method
3. Determination of bulk modulus of a liquid using ultrasonic interferometer
4. Planck's constant- Photoelectric cell
5. Band gap energy of a semiconductor — Four-probe method
6. Determination of L of a coil by Anderson's method
7. Determinations of wavelength of a laser source using plane diffraction grating and
8. thickness of a wire
9. Polarizability of liquids by finding the refractive indices at different wavelengths
10. Caliberation of thermistor
11. Magnetic susceptibility of a paramagnetic solution using Quincke's tube method
12. Determination of specific rotator power of a liquid using polarimeter
13. Four-probe method - Determination of resistivities of powdered samples
14. Determinatipn of refractive index of the liquid using biprism
15. Determination of coefficient of coupling by AC bridge method

B. Electronics Experiments

16. Characteristics of LED and photo diodes
17. Characteristics of laser diode and tunnel diode
18. Digital to analog converters using op-amp
19. Study of phase-shift oscillator using op-amp
20. Design and study of Schmitt trigges using op-amp
21. Flip-flops — - RS, JK and D
22. Decoder and encoder
23. Temperature coefficient using 555 timer
24. Design of pre-emphasis and de-emphasis circuits
25. Pulse-width and pulse-position modulations
26.

Text books:

1. C.C. Ouseph, U.J.Rao, V. Vijayendran, *Practical Physics and electronic*, Ananda book Depot, Chennai (2018).

2. M.N.Srinivasan, S.Balasubramanian ,R.Ranganathan, *A Text book of Pratical Physics*, Sultan Chand & Sons, New Delhi.(2015)

Supplementary Readings:

1. Samir Kumar Ghosh, *A Text book of Advanced Pratical Physics*, NCBA, Kolkatta.(2000).
2. D. Chattopadyay, P.C Rakshit, An Advanced Course in Pratical Physics, NCBA, Kolkatta.(2000).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	3	2	2
CO2	3	3	3	2	3
CO3	2	3	3	2	2
CO4	3	3	3	2	3
CO5	2	3	3	2	2

SEMESTER: II	TITLE: NUMERICAL METHODS AND C++ PROGRAMMING	CREDITS: 4
PART: ELECTIVE COURSE I (1)	COURSE CODE:	Hours/Week: 5

LO1	To give strong foundation in errors and the measurements
LO2	To make learning of numerical solution of algebric solution
LO3	To study the sums on interpolation
LO4	To create an understanding on numerical solutions
LO5	To develop knowledge about C++ programming

Unit I : Errors And The Measurement

General formula for errors – Errors of observation and measurement -Empirical formula - Graphical method – Method of averages – Least square fitting – curve fitting - parabola, exponential.

Numerical Differentiation and Integration: Newton's forward and backward difference formula to compute derivatives – Numerical integration: the trapezoidal rule, Simpson's rule – Extended Simpson's rule.

Unit II : Numerical Solution Of Algebraic Equations

Iteration method - false position method – Newton - Raphson method – Convergence and rate of convergence - Simultaneous linear algebraic equations: Gauss elimination method –Jordon's modification –Gauss-Seidel method of iteration.

Unit III : Interpolation

Linear interpolation - Lagrange interpolation Gregory - Newton forward and backward interpolation formula - Central difference interpolation formula - Gauss forward and backward interpolation formula -Divided differences - Properties - Newton's interpolation formula for unequal intervals.

Unit IV : Numerical Solutions Of Ordinary Differential Equations

N^{th} order ordinary differential equations – Power series approximation – Pointwise method – Solutions of Taylor series – Euler's method – Improved Euler's method – Runge-Kutta method– second and fourth order – Runge-Kutta method for solving first order differential equations.

Unit V : Programming In C++

Constants and variable - I/O operators and statements-Header file- function program -main functions- conditioner statement-switch statement-void function- -for ,while and Do While statements-break,continue and go to statement-Arrays.

Text Books:

1. S.S.Sastry, *Introductory Methods of Numerical Analysis*, Prentice Hall of India, New Delhi, Third Edition, 2005.
2. Brainerd and Walter S, *Programmer's Guide to Fortran90*, Springer publication, 1996.

Supplement Readings:

1. James B.Scarborough . *Numerical Mathematical Analysis*, Oxford & IBH Publishing Co.Pvt.Ltd., Sixth Edition, 1958.
2. S.S. Sastry, *Introductory Methods of Numerical analysis*, Prentice - Hall of India, New Delhi, Third Edition, 2003.

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	3	2	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
CO4	3	2	3	2	2
CO5	3	2	2	2	3

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SEMESTER: II	TITLE: SOLAR ENERGY	CREDITS: 4
PART: ELECTIVE COURSE I (2)	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	Understand basic characteristics of Solar Energy and Technologies.
LO2	Learn the design and importance of Solar Energy Collectors for Solar energy utilization.
LO3	Use the testing methods to analyze various solar energy collectors.
LO4	Understand different types of energy storage devices and its uses.
LO5	Learn and use the concepts of nano material fuel cell applications

Unit I: Heat Transfer & Radiation Analysis

Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Solar Radiation data- Solar radiation geometry - Determination of solar time – Solar energy on the tiled surface - Solar energy measuring instruments.

Unit II: Solar Collectors

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.-Evacuated solar collectors-Evacuated tube cover collectors-Thermal efficiency.

Unit III: Solar Heaters

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems-Solar air heater- Discription and classification non porous and porous type-transient analysis-Two pass solar air heaters

Unit IV: Solar Energy Conversion

Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process- texturization, diffusion, Antireflective coatings, metallization.

Unit V: Nanomaterials In Fuel Cell Applications

Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of nano technology in hydrogen production and storage.

Course Outcomes:

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

CO1	Understand the characteristics of solar radiation.
CO2	Gain knowledge in measuring the availability of solar radiation at a given location

CO3	Realize the role of solar collectors for effective solar energy utilization
CO4	Explain with the essentials of Solar thermal power generation
CO5	Familiarize with Photovoltaic method of Solar energy conversion into power.

Text Books:

1. G.D. Rai , *Solar energy utilization* -–Khanna publishers – Delhi 1987.
2. S.P. Sukhatme Solar energy – *principles of thermal collection & storage* –, TMH Delhi 1984.
3. G.N.Tiwari, Solar Energy, Narosa Publishing house, india (2012).

Supplement Readings:

1. R.H.Romer, W.H.Freeman.(1976)Energy – An Introduction to Physics
2. Maheshwar Sharon, Madhuri Sharon, Carbon "*Nano forms andApplications*", McGraw-Hill, 2010.

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	2
CO2	3	2	2	2	2
CO3	3	2	2	2	2
CO4	3	2	2	2	2
CO5	3	2	2	2	3

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SEMESTER: II	**TITLE: LASER PHYSICS AND NON LINEAR OPTICS**	**CREDITS: 4**
PART: ELECTIVE COURSE I (3)	**COURSE CODE:**	**Hours/Week: 5**

Learning Objectives

LO1	To understand the basic theory of laser action and the concept of Q-switching
LO2	To explain illustrate the working of various advanced Lasers available
LO3	To describe the basic Physics of nonlinear optics and demonstrate different NLO Phenomena
LO4	To understand the Multiphoton process
LO5	To learn the non linear optics

Unit I: Lasers Fundamentals and Types

Basic Construction and Principle of Lasing-Einstein Relations and Gain Coefficient - Creation of a Population Inversion- Three-Level System - Four-Level System - Threshold Gain Coefficient for Lasing- Laser types-He-Ne Laser-CO_2 Laser- Nd:YAG Laser- Semiconductor Laser.

Unit II: Laser Operation

Optical Resonator-Laser Modes-Axial modes- Transverse modes-Modification in Basic Laser Structure- Basic Principle of Mode Locking- Active Mode Locking -Passive Mode Locking-Q-Switching- Pulse Shaping.

Unit III: Laser Beam Characteristics

Wavelength-Coherence-Mode and Beam Diameter-Polarizations-Introduction to Gaussian Beam width-Divergence-Radius of Curvature-Rayleigh Range-Guoy Phase Shift-3-D Gaussian Beams -ABCD Law for Gaussian Beam-The Complex Radius of Curvature-Tensorial ABCD Law.

Unit IV: Focusing of Laser Beam

Diffraction- Limited spot size-M Concept of Beam Quality-Spherical Aberration- Thermal Lensing Effects-Depth of Focus-Tight focusing of laser beam - Angular Spectrum Representation of Optical Near Field-Aplanatic lens-Focusing of Higher- order laser modes-Radially Polarized Doughnut mode-Azimuthally Polarized Doughnut mode.

Unit V: Non Linear Optics

Introduction-Nonlinear Optical Media-The Nonlinear Wave Equation-Scattering Theory Born Approximation-Second-order Nonlinear Optics-Second-Harmonic Generation (SHG) and Rectification-The Electro-Optic Effect-Three-Wave Mixing- Frequency and Phase Matching-Third Harmonic Generation-Optical Kerr Effect- Self-Focusing- Four-Wave Mixing (FWM) - Optical Phase Conjugation (OPC)- Use of Phase Conjugators in restoration.

Course Outcome:

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

CO1	Explain the fundamental theory of laser actions
CO2	Brief out the various concepts of advanced laser systems
CO3	Describe the elementary ideas of focusing of laser

CO4	Elaborate the utilization of NLO phenomenon in various optical scenarios.
CO5	Illustrate the outline of application of l non linear optics

Text Books:

1. Nonlinear Optics - D.L. Mills - Basic Concepts, Springer, Berlin 1998.
2. Lasers and Nonlinear Optics -B.B. Laud-2nd Edn. New Age International (P) Ltd., New Delhi, 1991

Supplement Readings:

1. Nanomaterials: Processing and Characterization with Lasers.-Subhash Chandra Singh, HaiboZeng, ChunleiGuo, and WeipingCai -Wiley-VCH Verlag GmbH & Co. KGaA.(2012).
2. Walter Koechner-Solid state Laser Engineering-6th edition-Springer
3. Principles of Nano optics -L. Novotny and B. Hecht-Cambridge University Press(2006)
4. Encyclopedia of Optical Engineering- R.G.Driggers,C.Hoffman- Marcel Dekker(2003)
5. Laser Material Processing- M. Steen, J.Mazumder- Springer (2010).
6. Fundamentals of Photonics - Bahaa E. A. Saleh, Malvin Carl Teich-John Wiley Sons.

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	2
CO2	3	3	2	3	2
CO3	3	3	2	3	2
CO4	2	2	2	2	2
CO5	3	2	2	2	2

SEMESTER: II	TITLE: DISASTER MANAGEMENT	CREDITS: 3
PART: OPEAN ELECTIVE I (1)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To provide a general concept in the dimensions of disasters caused by nature beyond the human control.
LO2	To understand the disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
LO3	To learn the disaster management techniques.
LO4	To understand the Methods and techniques in disaster management.
LO5	To become aware of the role of social workers at the time of disaster.

Unit I : Understanding Disasters

Meaning, Concept – Type of Disasters – Effects/ Impacts of Disasters – Disaster Vulnerability of India: Lessons from Bhopal Gas Tragedy, Gujarat Earth Quake, Orissa Super Cyclone, Tsunami and Chennai- Cuddalore Floods.

Unit II : Disaster Management Cycle

Preparedness, Rescue/Recovery, Relief, Rehabilitation and Reconstruction. Factors influencing disaster preparedness and response. Disaster Management – Policy and Strategies Disaster Management Policy (2005).

Unit III : Disaster Management Act (2005)

Community Based Disaster Management (CBDM)– Restoration of Livelihood – Disaster Insurance – Insurance as an agency for disaster mitigation - Income Generation Activities and Housing - Task Force Groups – Advocacy.

Unit IV : Methods and Techniques

Vulnerability Analysis - Survival skills - Creating Awareness through IEC and Media – Training for Youth (CPR, Fire Fighting and Mock Drill) - Relief Camp Organisation - Recovery after disasters**.**

Unit V : Role Of Social Workers

In Psycho-social Support. Role of Agencies in Disaster Management: Role of Government in Disaster Management – National Disaster Management Authority (NDMA) – Role of International Organisations and Civil Society Organizations.

Course Outcome:

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

CO1	Understand the dynamic factors of disasters and their impact at an individual and societal level.
CO2	Deal with disaster preparedness, crisis management, risk reduction and rehabilitation and understand how they are connected.
CO3	Identify the role of different agencies in Disaster Management.
CO4	Apply various methods and techniques of disaster management.
CO5	Know the role of frontline social workers.

Text Books :

1. *Disaster Prevention and Mitigation*, United Nations Disaster Relief Coordination, New York. (1982)
2. Form William H and Sigmund Nosow, *Community in Disaster*, Harper and brothers Publishers, New York, (1958)
3. Julie Freestone And Rudi Raab, *Disaster Preparedness*, Viva Books Pvt Ltd, New Delhi, (2004)

Supplement Readings:

1. *Renewable Energy and Energy Harvesting*, Nilamoni Saikia, Mahaveer Publications, First edition

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	2
CO2	3	2	2	3	2
CO3	2	2	2	3	2
CO4	2	2	2	2	2
CO5	2	2	2	3	2

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SEMESTER: II	TITLE: COMMUNICATION PHYSICS	CREDITS: 3
PART: OPEN ELECTIVE I (2)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To understand the basics of wave propagations and the concepts of micro wave Communication
LO2	To learn the basic principles of Fiber Optics Communication & networking system.
LO3	To study the elements of RADAR communication.
LO4	To update the knowledge on satellite communication and the equipment used.
LO5	To introduce the preliminary concepts of mobile communication systems.

Unit I : Wave Propagation and Micro Wave Communication

Ionospheric Layers – Ground Wave Propagation – Sky Wave Propagation – Skip Waves – Space Waves.

Micro Waves : Generation – Multicavity Klystron – Reflex Klystron – Magnetron –Travelling Wave Tubes (TWT) – MASER – Gun Diode – Micro Wave Antennas.

Unit II : Radar Communication

Basic RADAR System – Radar equation - Radar range - Antenna Scanning, pulsed radar system – Radar Antennas – Duplexer – Radar Receivers - Plan position indicators -search radar - tracking radar - moving target indicators - Doppler effect - MTI Principle - CW Doppler radar - frequency modulator CW radar.

Unit III : Satellite Communication

History of satellites - Satellite orbit - basic components of satellite communication system - constructional features of satellites - commonly used frequency in satellite communication system – Transponders – Digital Carrier Transmission - multiple access -communication package - antenna power – source - satellite foot points - satellite communication system in India.

Unit IV : Optical Fibre Communication

Elements of an optical fibre communication system – fiber lasers - Multiplexers -wavelength division multiplexing - Electrooptic and Acousto-optic modulation - Coherent optical fibre communication system – OFC Networks -Local Area Networks - Bus, ring and star topologies - optical fibre regenerative repeater - optical amplifiers - basic applications - Low speed industrial optical fibre networks – principles of WDM – passive components – Couplers – Multiplexing and De-multiplexing.

Unit V: Mobile Communication

Evolution of Mobile Communication – Multiplexing – Modulation - The concept of cell - the cellphone, Principles of SDMA, FDMA, TDMA and CDMA and their comparison VSAT (very small aperture terminals), GPRS – Protocal – Mobile IP, IP Packet delivery –optimization - Modem, Wi-Fi-4G (basic ideas only).

Course Outcomes:

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

CO1	Know the basics of wave propagations and the concepts of micro wave communication
CO2	Understand the basic principles of Fiber Optics Communication & Networking system.
CO3	Describe the elements of RADAR communication.
CO4	Acquire the knowledge on satellite communication and the equipments used.
CO5	Learn and apply the preliminary concepts of mobile communication systems.

Text Books:

1. George Kennedy and Davis, *Electronic Communication System,* TATA Mc Graw Hill, Fourth edition, (1999).
2. K.C.Kupta, *Micro Waves,* Wiley Eastern Ltd., (1995).
3. Anokh Singh and Chopra A.K., *Principles of communication Engineering,* S.Chand & Company Ltd. (2013).
4. L.Poornima Thangam, *Satellite communication,* Charulatha Publications (2012).
5. Jochen H Schiller, *Mobile Communication,* Pearson Education, (2004).
6. J.C.Palais, *Fiber Optic Communications*, Pearson, 2005.
7. E. John M. Senior, *Optical Fibre Communications*: Principles and Practice, Pearson, 2010.
8. F. Govind P. Agrawal, *Fiber Optic Communication Systems*, John Wiley & Sons Inc., New York, 2012

Supplementary Readings:

1. A.K. Maini, *Micro Waves and Radar - Principles and applications,* Khanna Publications, New Delhi, (2001).
2. Wayne Tomasi, *Advanced Electronic Communications Systems,* PHI Learning Pvt. Ltd., New Delhi, (2009).
3. G. Gerd Keiser, *Optical fibre Communications*, Tata-McGraw-Hill, 2008.
4. H. Sudhir Warier, *The ABC's of Fiber Optic Communication*, Artech House, 2017

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	3	2	3	2
CO2	3	2	2	2	2
CO3	3	2	2	3	2
CO4	3	2	2	3	2
CO5	2	2	2	3	2

SEMESTER: II	TITLE: BASICS OF RENEWABLE ENERGY SOURCES	CREDITS: 3
PART: OPEN ELECTIVE I (3)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To learn various types of alternative sources of energy.
LO2	To understand the basics and applications of solar energy.
LO3	To understand harvesting methods of wind, ocean, geothermal and hydro energies.
LO4	To learn the basics of piezo-electric effect and its applications in energy harvesting.
LO5	To understand the various forms of electromagnetic energy harvesting techniques.

Unit I : Fossil Fuels And Alternative Sources Of Energy

Fossil fuels and nuclear energy, need of renewable energy, non – conventional energy sources, Wind energy, Tidal energy, Wave energy systems, Ocean Thermal Energy Conversion, Solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, hydroelectricity, basics of Energy Auditing.

Unit II : Solar Energy

Solar energy, storage of solar energy, solar pond, non – convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning, need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits and sun tracking systems.

Unit III : Wind Energy

Fundamentals of wind energy, wind turbines and different electrical machines in wind turbines, power electronics interfaces, grid interconnection topologies.

Ocean energy **:** Ocean energy potential against wind and solar, wave characteristics and statistics, wave energy devices. Tide characteristics tide energy technologies.

Geothermal and hydro energy**:** Geothermal resources, geothermal techniques. Hydropower resources, hydro technologies and environmental impacts.

Unit IV : Piezoelectric Energy

Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, piezoelectric parameters and modelling piezoelectric generators, piezoelectric harvesting applications and human power.

Unit V : Electromagnetic Energy

Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries and power consumption. Environmental issues and Renewable sources of energy, sustainability.

Course Outcomes:

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

CO1	Learn various types of alternate sources of energy
CO2	Understand the basic and applications of Solar energy
CO3	Understand the harvesting methods of wind, ocean, geothermal and hydroenergies.
CO4	Learn the basics of piezo electric effects and its application in energy harvesting.
CO5	Understand the various forms of electromagnetic energy harvesting.

Text Books:

1. S.C.Bhatia and R.K.Gupta, *Woodhead Text book of Renewable Energy*, edition, (2018).
2. Niranjan Sahu, *Renewable Energy and Energy Harvesting*, KAAB Publications, (2017).

Supplementary Readings:

1. K.P.Prasad Rao and P.Vijaymuni, *Applications of Renewable Energy Sources – Notion Press*, (2020).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	2
CO2	3	2	2	3	3
CO3	2	2	2	3	2
CO4	3	2	2	2	2
CO5	2	2	2	3	2

SEMESTER: III	TITLE: ELECTROMAGNETIC THEORY	CREDITS: 4
PART: CORE COURSE X	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To develop a strong background in electromagnetic theory
LO2	To understand the nature of electric and magnetic force fields and the intricate connection between them
LO3	To provide a clear and logical presentation of Electrostatics and electrodynamics
LO4	To understand and use various mathematical tools to solve Maxwell equations in problems of wave propagation and radiation
LO5	To make the students understand the source of production and propagation of EM waves

Unit I: Electrostatics

Coulomb's law; the electric field – line, flux and Gauss's Law in differential form - the electrostatic potential; conductors and insulators; Gauss's law - application of Gauss's law – curl of E - Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges –capacitors. Potentials: Laplace equation in one dimension and two dimensions – Dielectrics –induced dipoles – Gauss's Law in the presence of dielectrics.

Unit II: Magnetostatics

Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law – divergence and curl of B – Ampere's Law – Electromagnetic induction - comparison of magnetostatics and electrostatics – Magnetic vector potential.Magnetization: effect of magnetic field on atomic orbit – Ampere's Law in magnetized materials – ferromagnetism.

Unit III: **Electromotive Force**

Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation in free space and linear isotrophic media – continuity equation – Poynting theorem.

Electromagnetic waves in vacuum**:** Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization.

Unit IV: Electromagnetic Waves

The wave equation for E and B – Monochromatic Plan waves – energy and momentum in electromagnetic waves – electromagnetic waves in matters –TE waves in rectangular wave guides – the co-axial transmission line. Potentials: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potential form.

Unit V: Application of Electromagnetic Waves

Boundary conditions at the surface of discontinuity – Reflection and refraction of E.M waves at the interface of non – Conducting media – Kinematic and dynamic properties –Fresnel's equation – Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of incidence – Reflection and transmission co-efficients at the interface between two non–Conducting media – Brewster's law and degree of polarization – Total internal reflection.

Course Outcomes

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

CO1	have a depth knowledge of electrostatics and clearly understand dielectric polarization.
CO2	Know the fundamental laws to find the magnetic field of a source. Apply the magnetic scalar and vector potentials to find the magnetic field due to localized source.
CO3	use Maxwell's equations for a system of charge and electromagnetic field.
CO4	know the propagation of electromagnetic waves in free space, dielectric medium and conducting medium.
CO5	Understand about the oscillating dipole. Know how the power radiated from a linear antenna. Understand clearly antenna arrays.

Text Books:

1. David J. Griffiths, *Introduction to Electrodynamics* , 4th Edition, Pearson.
2. SathyaPrakash, *Electromagnetic Theory and Electrodynamics* , KedarNath RamNath and Co, 2017.
3. B.B Laud, *Electromagnetics,* Wiley Eastern Company, 2000.
4. Wazed Miah, *Fundamentals of Electromagnetic,* Tata Mc Graw Hill, 1980.
5. Narayana rao, *Basic Electromagnetics with Application,* (EEE) Prentice Hall, 1997.

Supplementary Readings:

1. John R.Reitz, Frederick J Milford and Robert W.Christy, *Fundamentals of Electromagnetic Theory,* Third edition, Narosa Publishing House, New Delhi –1998.
2. J.D. Jackson, Classical Electrodynamics , II Edition, Wiley Eastern Limited, 1993.
3. B.B Laud, Electromagnetics , Wiley Eastern Company, 2000.

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	3	2	2	2	3
CO3	3	2	3	2	3
CO4	3	2	2	2	3
CO5	3	3	2	3	2

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SEMESTER: III	TITLE: THERMODYNAMICS AND STATISTICAL MECHANICS	CREDITS: 4
PART: CORE COURSE XI	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To provide adequate introduction on the postulates of Thermodynamics
LO2	To understand the Transport properties and related equilibrium concepts
LO3	To learn the basics of classical statistical mechanics and to understand some of their Applications
LO4	To learn the basics of quantum statistical mechanics and to understand some of their Applications
LO5	To train to apply quantum mechanical statistics to various applications

UnitI: Thermodynamics

Basic postulates of thermodynamics – Phase space and ensembles – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation – Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials–Maxwell relations – Thermodynamic relations – Microstates and macrostates – Ideal gas –Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems – Density of states and volume occupied by a quantum state

Unit II: Microcanonical, Canonical and Grand Canonical Ensembles

Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics - Partition function and free energy of an ideal gas –The grand partition function – Relation between grand canonical and canonical partition functions – One-orbital partition function

Unit III: Bose-Einstein, Fermi-Dirac And Maxwell-Boltzmann Distributions

Bose-Einstein and Fermi-Dirac distributions – Thermodynamic quantities – Non-interacting Bose gas and thermodynamic relations – Chemical potential of bosons – The principle of detailed balance – Number density of photons and Bose condensation - Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero and low temperature – Fermi energy and Fermi momentum - Maxwell-Boltzmann distribution law for microstates in a classical gas - Physical interpretation of the classical limit – Fluctuations in different ensembles.

Unit IV: Transport And Non-Equilibrium Processes

Derivation of Boltzmann transport equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation - Transport processes; One speed and one dimension - All speeds and all directions - Conserved properties - Distribution of molecular velocities – Equipartition and

Virial theorems – Random walk - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Thermal conduction - The heat equation

UNIT V: Applications of Q.S.M

Ideal Bose gas-photons –Black body and planck radiation –law-photons-Einstein theory of solids-Liquid Helium - Ideal Fermi gas:Properties-Degenercy-Electron gas-pauli paramagnetism Ferromagnetism:Isling and Heisenberg models.

Course Outcomes

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

CO1	have adequate knowledge on the basics of thermodynamics.
CO2	U understand the kinetic theory and transport properties.
CO3	know the Basic concepts of classical statistics and applications
CO4	know the Basic concepts of quantum statistics.
CO5	describe the role of quantum statistics to various real life problems.

Text Books:

1. C.Kittel, *Elementary Statistical Physics,* John Wiley & Sons, 2004.
2. F.Reif, *Statistical and Thermal Physics,* McGraw Hill, Fifth Edition, 2010.
3. Gupta & Kumar, *Statistical Mechanics,* 20th Edition, Pragati Prakashan, Meerut, 2003.

Supplementary Readings:

1. Paperback, Reif, *Fundamentals of Statistical and Thermal Physics,* Sarat Book Distributors (2010).
2. B.B. Laud , *Fundamentals of Statistical Mechanics Paperback,* New Age International Private Limited, Jan 2012.
3. C.Kittel, *Elementary Statistical Physics,* John Wiley & Sons, 2004.
4. F.Reif, *Statistical and Thermal Physics,* McGraw Hill, Fifth Edition, 2010.
5. Gupta & Kumar, *Statistical Mechanics,* 20th Edition, Pragati Prakashan, Meerut, 2003.
6. B.K.Agarwal and M.Eisner, *Statistical Mechanics,* Second Edition, New Age International Private Limited, Delhi, 2016.
7. E.S.R.Gopal, *Statistical Mechanics and Properties of Matter (Theory and Applications),* Ellis Horwood Ltd, 1974.

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	3	2	2	2	3
CO3	3	2	3	2	3
CO4	3	2	2	2	3
CO5	3	3	2	3	2

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SEMESTER: III	TITLE: PRACTICAL – III (MICROPROCESSOR AND C++ PROGRAMMING)	CREDITS: 4
PART: CORE COURSE XII	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To create basic skills in microprocessor practical
LO2	To develop the ideas about in microprocessor
LO3	To provide knowledge on assembly language programming in microprocessor
LO4	To cater basic idea of using interface with microprocessor.
LO5	To create skill on microcontroller applications.

LIST OF EXPERIMENTS

(Any Twelve Experiments - Six experiments from each part)

(MICROPROCESSOR AND C++ PROGRAMMING)

A. Microprocessor (8085)

1. Finding the largest and smallest numbers in a data array
2. Arranging a set of numbers in ascending and descending orders
3. Study of multibyte decimal addition
4. Study of multibyte decimal subtraction
5. Interfacing hexa key board (IC 8212)
6. Study of seven segment display
7. Study of DAC interfacing (DAC 0900)
8. Study of ADC interfacing (ADC 0809)
9. Study of timer interfacing (IC 8253)
10. Study of programmable interrupt controller (IC 8259)
11. Traffic control system
12. Digital clock
13. Study of addition using microcontroller
14. Study of subtraction using microcontroller
15. Control of stepper motor using microprocessor

B. C++ Programming

1. Least-squares curve fitting - Straight-line fit
2. Least-squares curve fitting - Exponential fit
3. Least-squares curve fitting - Exponential fit
4. Real roots of one-dimensional nonlinear equations — Newton Raphson method

5. Complex roots of one-dimensional nonlinear equations -- Newton— Raphson method
6. Numerical integration - Composite trapezoidal rule
7. Numerical integration - Composite trapezoidal rule
8. Numerical integration - Composite Simpson's 1/3 rule
9. Solution of a second-order ODE - Euler method
10. Solution of a first-order ODE - Fourth-order Runge—Kutta method
11. Uniform random number generation - Park and Miller method
12. Gaussian random number generation - Box and Muller method
13. Evaluation of definite integrals - Monte Carlo method
14. Calculation of mean and standard deviation of a set of uniform randomNumbers
15. Computation of eigenvalues of linear harmonic oscillator by numerically solving Schrodinger equation

Course Outcome:

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

CO1	know basic skills in microprocessor practical
CO2	understand the ideas about in microprocessor
CO3	get the knowledge on assembly language programming in microprocessor
CO4	know basic idea of using interface with microprocessor.
CO5	get skill on microcontroller applications.

Text Books:

1. V.Vijayendran, *Fundamentals of Microprocessor 8085 - Architecture, programming and interfacing,* S.Viswanathan Printers & Publishers Pvt. Ltd, Chennai. (2008).
2. and Avatar Singh, *16-Bit and 32-Bit Microprocessors: Architecture*, Software, and Interfacing Techniques,Global Edition, 4th Edition, Pearson,U.K. (2014).
3. Kenneth Ayala, *The 8051Microcontroller*, Cengage Learning India, New Delhi. (2013).
4. A.P. Godse and D.A. Godse, *Microprocessors and Microcontrollers*, Technical Pub.,Pune. (2008).

Supplement Readings:

1. R.S. Gaonkar, '*Microprocessor Architecture Programming and Application'*, with 8085, Wiley Eastern Ltd., New Delhi. (2013).
2. Badri Ram, *Fundamentals of Microprocessors and Microcomputers*, Dhanpat Rai and sons, New Delhi. (1995).
3. W.A. Triebel and Avatar Singh, *The 8086 / 8088 Microprocessors-Programming, Software, Hardware and application*, Prentice Hall of India, New Delhi.(2003)
4. Krishna Kant, "*Microprocessor and Microcontrollers*", Eastern Company Edition, Prentice Hall of India, New Delhi. (2007)

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	2
CO2	3	2	3	2	2
CO3	2	2	3	2	2
CO4	2	2	3	2	2
CO5	2	2	3	2	2

SEMESTER: III	TITLE : RESEARCH METHODOLOGY	CREDITS: 4
PART: CORE COURSE XIII	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To identify and formulate the research problem with the consideration of research ethics.
LO2	To learn various types of scientific data analysis.
LO3	To learn to utilize the facilities of computers in research.
LO4	To learn the scientific writing techniques.
LO5	To familiarize the codes of IPR and the funding agencies.

UNIT - I : MEANING OF A RESEARCH – FUNCTION OF RESEARCH PROBLEM

Meaning of research-function of research-characteristics of research-steps involved in research-Research in pure and applies sciences-Inter discipilinary research

Factors which hinder research-Significance of Research-Research and scientific methods – Research process-Criteria of good research- Problems encountered by researchers-Literature review.

UNIT - II : IDENTIFICATION OF RESEARCH PROBLEM

Selecting the research problem-Necessity of defining the problem-source of problems-Goals and criteria for identifying problems of research

Perception of Research design-Techniques involved in defining the problem-Source of Problems –Personal consideration

UNIT - III : RESEARCH DESIGN

Formulation of Research -Need for Research design-Features of good design - Important concepts related to research design.

Different Research design-Basic Principles of experimental designs-Computer and internet in design

UNIT - IV : SCIENTIFIC WRITING TECHNIQUES

Scientific Writing – definition – organizing a scientific paper – title – listing of authors and address – abstract – introduction – materials and methods section – result section – discussion section – acknowledgement – references – design of effective tables – effective illustrations –manuscript submission – review process – publishing process. Publication in peer reviewed journals – Power Point and Poster presentation – Writing of Synopsis - Thesis plagiarism

UNIT - V : PATENTS AND FUNDING AGENCIES

Patents **:** History – Definition – Patent system – need for patency – Legal aspects

Intellectual Property Right**:** Fundamentals of IPR -Awareness of IPR - International practices - Indian system of IPR – Benefits.

Funding Agencies**:** Need for Research funding – Four types of funding – Government supported funding agencies – Private funding Agencies - International funding Agencies –General Format of Application – Utilization - Account submission – Acknowledgements.

Course Outcomes

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

CO1	Identify and formulate the research problem with the consideration of research ethics.
CO2	Learn various types of scientific data analysis.
CO3	Utilize the facilities of computers in research.
CO4	Learn the scientific writing techniques.
CO5	Know the funding agencies and the codes of IPR.

TEXT BOOKS :

1. J. Anderson, B.H. Durston and M. Poole, *Thesis and Assignment writing*, Wiley Eastern, New Delhi, (1977).
2. Rajammal Devadas, *Hand Book of Methodology of Research*, R.M.M. Vidyalaya Press, (1976).
3. C.R. Kothari, *Research methodology: Methods and Techniques,* New age International, New Delhi, (2006).
4. K.Ravichandran, K.Swaminathan, A.T.Ravichandran and C.Ravidhas, *Research Methodology and Scientific Writing*, Jazam Publication,Tiruchirappalli, (2017).

SUPPLEMENTARY READINGS :

1. G.W. Snedecor and W.G. Cochrans, *Statistical Methods,* Lowa state university Press (1967).
2. S.S. Sastry, *Introduction Methods of Numerical Analysis,* Prentice Hall of India Pvt. Ltd., (1977).
3. J. Anderson, *Thesis and Assignment Writing,* Wiley Eastern Ltd., (1977).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	**3**	**2**	**2**	**3**	**2**
CO2	**3**	**3**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**3**
CO4	**3**	**3**	**2**	**3**	**2**
CO5	**3**	**3**	**2**	**2**	**3**

SEMESTER: III	TITLE: MICROPROCESSORS AND MICROCONTROLLER	CREDITS: 4
PART: ELECTIVE COURSE II (1)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To learn the architecture of 8085 microprocessor, interrupts and timing diagrams
LO2	To write assembly language programmes to 8085 microprocessor
LO3	To study the architecture of 8086 microprocessor
LO4	To familiarize the architecture of 8051 microcontroller and its programming
LO5	To understand the principle of interfacing with peripheral devices and study the interfacing devices of 8085 and 8051

Unit I: MicroprocessorArchitecture

8085 microprocessor architecture - Address Bus.Control Bus.Data Bus- Various registers- Central processing unit of micro computers - Timing and control unit - Instruction and data flow - System timings.

Unit II:lnstruction and programming (8085)

Instruction set-Data transfer group-Logical group-Branch group-Stack and l/o control instructions-Addressing modes.

Addition - Subtraction - Multiplication - Division - BCD arithmetic - Searching an array of a given number - Choosing the biggest and smallest numbers from a list - Ascending and descending orders - Square root of a number - Time delay - square wave generator.

Unit III: Interfacing memory and I/O devices

Interfacing memory and devices - I/O and Memory mapped I/O - Type of interfacing devices - Data transfer schemes - Programmed and DMA data transfer schemes - Programmable Peripheral Interface (8255A) - 8253 Timer Interface - DMA controller - Programmable Interrupt controller (8259) - Programmable communication Interface (8251).

Unit IV: Microcontroller 8051

Features of 8051 - Architecture - Pin configuration - Memory organization - External data and program memory-Counters and timers - Serial data input/output - Interrupt structure -External interrupts - Addressing modes - Comparison between microprocessor and microcontroller.

Unit V: 8051 Instruction Set and Programming

Instruction set - Data transfer, arithmetic and logical instructions - Boolean variable manipulation instructions - Program and machine control instructions - Simpleprograms -Addition and subtraction of two 8-bit and 16-bit numbers - Division -Multiplication - Largest number in a set - Sum of a set of number

Instruction set - Data transfer, arithmetic and logical instructions - Boolean variable manipulation instructions - Program and machine control instructions - Simpleprograms -Addition and subtraction of two 8-bit and 16-bit numbers - Division -Multiplication - Largest number in a set - Sum of a set of number

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

CO1	Know various interrupts in 8085, timing diagrams for memory read/write cycle.
CO2	Write assembly language programs
CO3	Understand the hardware of 8086 and its modes of operations.
CO4	Understand the hardware of 8051 and to explain the instruction set, addressing modes and arithmetic operations
CO5	Know how to interface the peripheral devices with 8085 and 8051 and describe the different interfacing devices and can demonstrate the interfacing of DAC / ADC and stepper motor

TEXT BOOKS :

1. V.Vijayendran, *Fundamentals of Microprocessor 8085 - Architecture, programming and interfacing*, S.Viswanathan Printers & Publishers Pvt. Ltd, Chennai. (2008).

2. Avatar Singh, *16-Bit and 32-Bit Microprocessors: Architecture*, Software, and Interfacing Techniques,Global Edition, 4th Edition, Pearson,U.K. (2014)

SUPPLEMENTARY READINGS:

1. Kenneth Ayala, *The 8051Microcontroller*, Cengage Learning India, New Delhi. (2013)

2 . A.P. Godse and D.A. Godse, *Microprocessors and Microcontrollers*, Technical Pub.,Pune.

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	**3**	**2**	**2**	**3**	**2**
CO2	**3**	**3**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**3**
CO4	**3**	**3**	**2**	**3**	**2**
CO5	**3**	**3**	**2**	**2**	**3**

SEMESTER: III	TITLE: MATERIALS PHYSICS AND PROCESSING TECHNIQUES	CREDITS: 4
PART: ELECTIVE COURSE II (2)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To impart knowledge on various material growth, synthesis and processing techniques
LO2	To make understood various processes related to Plasma Processing
LO3	To give an in-depth understanding on the principles and applications of Vacuum Techniques
LO4	To introduce some important advanced materials of smart and futuristic nature.
LO5	To learn the characterization techniques that gives compositional analysis.

UNIT-I: CRYSTAL GROWTH

Significance of crystal growth-Naturally occurring crystal growth processes-Crystal growthprocesses in laboratory and industrial scale- Classification of crystal growth methods-Growthfrom solutions -Nucleation: Homogeneous and heterogeneous, Solubility phase diagram-Saturation-Supersaturation- Metastable zone width-Slow evaporation and slow cooling methods,Growth from gel-Growth from flux-Growth from melt- Bridgeman-Stockbarger method-Czochralski pulling method- Growth from vapour-Sublimation method.

UNIT-II: PLASMA PROCESSING

Basics of plasma: Introduction, Types of plasma; Properties of plasma; V-I characteristics;Advantages of plasma processing.Thermal plasma: Principles of plasma generation‖DC plasma torches; AC plasma torches;RF plasma torches, Plasma spraying; Structure of sprayed deposits, Plasma spheroidization;Plasma decomposition; Treatment of hazardous wastes – Synthesis of ultrafine/nanopowders. Plasma melting and remelting.Non-thermal plasma:

UNIT-III: VACUUMTECHNIQUES

Units and range of vacuua – Formulas for important quantities – Qualitative description of pumpingprocess – Surface processes and outgassing – Gas flow mechanism – Classification of pumps :Positive displacement pumps – Kinetic pumps – Entrapment pumps - Classification of pressuregauges : Total pressure gauges –Hydrostatic pressure gauges - Thermal conductivity gauges –Ionization gagues – Vacuum system : simple rotary, diffusion, turbo molecular, ultra-high vacuumand cryo-pumped systems.

UNIT-IV: GROWTH TECHNIQUE OF THINFILMS AND NANOMATERIALS

Plasma arc discharge-sputtering-chemical vapour deposition-pulsed laser deposition-molecular beam epitaxy-Electrochemical deposition- SILAR method

Solid-State Reaction - Sol-Gel Technique - Hydrothermal growth - Ball Milling – Combustion synthesis – Sonochemical method - Microwave synthesis – Coprecipitation

UNIT-V: CHARACTERIZATION TOOLS

Working principles and instrumentation –X ray diffraction– X ray photo electron spectroscope– Auger Electron Spectroscope –Rutherford back scattering spectroscope– Atomic Force Microscope –Scanning ElectronMicroscope – Scannind Tunneling Microscope

BOOKS FOR REFERENCE:

1. Maissel and Glange, Handbook of Thin Film McGraw Hill, First Edition 1970
2. Roth, Vacuum Technology, North Holland, Third Edition, 1990.
3. Pipko A, Pliskosky V, Fundamentals of Vacuum Techniques, MIR Publishers First Edition 1984

SUPPLEMENTARY READINGS

1. K. L. Chopra, Thin Films Phenomena, Thin Films Phenomena 1969

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	3	3	2	3
CO3	3	3	3	2	3
CO4	3	3	2	3	2
CO5	3	3	2	2	3

SEMESTER: III	TITLE: BIOPHYSICS	CREDITS: 4
PART: ELECTIVE COURSE II (3)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To study the basic concepts involved in cell biology.
LO2	To understand and apply various tools for cell
LO3	To apply optical and diffraction techniques in bio-physics
LO4	To learn various separations techniques based on physics principles.
LO5	To introduce bio-materials and implanting techniques.

UNIT-I: CELL ORGANIZATION

Cell as the basic structural unit- Origin & organization of Prokaryotic and Eukaryotic cell- Cell size & shape- Fine structure of Prokaryotic & Eukaryotic cell organization (Bacteria, Cyanobacteria, plant & Animal cell)- Internal architecture of cells- cell organelles- compartment & assemblies membrane system- Ribosome- Polysomes- Lysosomes- Peroxisomes- Connection between cell & its environment- Extracellular Matrix.

UNIT-II: TOOLS IN CELL BIOLOGY

Light microscope- Resolving Power- Phase contrast microscope- Detection of small differences in refractive indices- Interference microscope-, Dark field microscope- Polarization microscope-Fluorescence microscope- Cytophotometry methods- Flowcytometry & cell sorting- Electron microscopy- specimen preparation- Scanning Electron Microscopy (SEM)- Transmission Electron Microscopy (TEM)-Applications.

UNIT-III: MACROMOLECULAR STRUCTURE

Nucleic acid structure: Chemical structure of the nucleic acid - Conformational possibilities of monomers and polymers- Double helix structure of DNA- Polymorphism of DNA- DNA nanostructures and the structure of transfer RNA.

Proteins structure: Amino acids and the primary structures of proteins – Secondary – Tertiary -Quaternary structure and virus structure.

UNIT-IV: SEPERATION TECHNIQUES

Centrifugation**:** Principle of centrifugation –Analytical ultracentrifugation – Differential centrifugation – Density gradient centrifugation.

Chromatography**:** Principles of chromatography– Paper chromatography – Thin layer chromatography (TLC) – Gas liquid chromatography (GLC) – High performance liquid chromatography (HPLC).

Electrophoresis: Principles – Factors affecting the migration of substances – Supporting media in electrophoresis – Gel electrophoresis – Polyacrylamide gel electrophoresis (PAGE) – Sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS-PAGE).

UNIT-V: OPTICAL & DIFFRACTION TECHNIQUES

Circular Dichroism and optical rotator dispersion-: Plane, circular and elliptical polarization of light- Absorption by oriented molecules- Dichroic ratio of proteins and nucleic acids- Circular dichroism (CD) - optical rotatory disperson (ORD) - Relation between CD and ORD-Application of ORD in conformation and interactions of biomolecules.

Crystallization of proteins- preparation of heavy metal derivatives- Patterson synthesis-isomorphous replacement methods- structure factors of centro-symmetric and non-centrosymmetric crystals- General remarks on Protein-Structure determination from X-ray diffraction data-Neutron diffraction-, Electron diffraction-, Synchrotron diffraction, Application in Biomolecular structural studies.

Course Outcomes:

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

CO1	Know the basic concepts involved in cell biology.
CO2	Understand and apply various tools for cell
CO3	Apply optical and diffraction techniques in bio-physics
CO4	Describe various separations techniques based on physics principles.
CO5	Get introduced to bio-materials and implanting techniques.

T EXT BOOKS :

1.M.A.Subramanian, *Biophysics*, MJP Publishers, (2005).
2.L.Veerakumari, *Bioinstrumentation*, MJP Publishers, (2006).
3.A.C.Deb, *Fundamentals of Biochemistry*, New central book agency, (2011).

SUPPLEMENTARY READINGS :

1.Mishra, P.S., *Biophysics,* V.K. Enterprises, (2010).
2.Geoffrey M. Cooper, *The Cell : A Molecular Approach,* ASM Press, (2019).
3.Vasantha Pattabhi, Gautham, N, *Biophysics,* Narosa Publishing, (2013).

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	2	2	2	2	2
CO4	2	3	3	3	3
CO5	3	3	3	3	3

SEMESTER: III	TITLE: SPECTROSCOPY AND LASERS	CREDITS: 3
PART: OPEN ELECTIVE II (1)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To give knowledge about the microwave spectroscopy and its applications.
LO2	To educate the regarding the important of IR and UV spectroscopy
LO3	To expose the student to the effective study and applications of Raman spectroscopy.
LO4	To introduce knowledge on basics of laser.
LO5	To study the types and applications of lasers.

Unit I: Microwave Spectroscopy

Rotational spectra of diatomic molecules -Effect of isotopic substitution - The non – rigid rotator - Rotational spectra of polyatomic molecules – Linear molecules - Experimental techniques.

Unit II: IR and UV spectroscopy

Vibrating diatomic molecule -Diatomic vibrating rotator-Linear molecules - Analysis by infrared techniques – Characteristic- group frequencies - Ultraviolet spectroscopy – determination of band gap – Uses.

Unit III: Raman Spectroscopy

Raman effect - Quantum theory of Raman effect - Rotational and vibrational Raman shifts of diatomic molecules- Raman Spectroscopy instrumentation-applications- group frequencies.

Unit IV: Lasers-Fundamentals And Types

Basic Construction and Principle of Lasing-Einstein Relations and Gain Coefficient - Population Inversion - Laser types-He-Ne Laser-CO_2 Laser- Nd:YAG Laser- Semiconductor Laser.

Unit V: Laser – Applications

Industry: Laser cutting - welding - drilling – Laser in Hologram -Medical: Lasers in Surgery - Lasers in ophthalmology - Lasers in cancer treatment- Communication: Laser in Optic fibre communication.

Course Outcomes:

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

CO1	Study briefly about the microwave spectroscopy.
CO2	Improve knowledge about IR and UV spectroscopy with its applications.
CO3	Understand the Raman spectroscopy and applications.
CO4	Understand the basics of laser action
CO5	Study various types Laser and its applications

Text Books:

1. Colin N. Banwell and Elaine M. Mc Cash, *Fundamentals of Molecular Spectroscopy*, Mc Grow – Hill Education (India) Pvt. Ltd.,New Delhi. (5^{th}edition), (2013).
2. G.R. Chatwal and S.K.Anand, *Spectroscopy -Atomic and Molecular*, Himalaya Publishing House (5^{th} edition). (2016).
3. Arthur Beiser, *Concepts of Modern Physics,McGraw Hill*, New York, (1995).
4. D.N. Sathyanarayana, *Vibrational Spectroscopy*, New Age International, New Delhi. (2015).
5. G. Aruldhas, *Molecular Structure and Spectroscopy*, Prentice Hall, New Delhi. (2006).
6. Gupta, Kumar and Sharrna, *Spectroscopy*.Pragathi Prakashan - 23^{rd} edition (2011).
7. N. Avadhanulu, S. Chand & Company *An introduction to LASERS* (2001).

SUPPLEMENTARY READING

1. R.P Straughen and S. Walker, *Spectroscopy (Vol. I, II, III), Chapman & Hall*, London. (1976).
2. G. Aruldhas, *Molecular Structure and Spectroscopy*, PHI Learning Private Limited – Hall of India, 2^{nd} edition. (2007).
3. Walter S. Struve, *Fundamentals of Molecular Spectroscopy*, John Wiley and Sons, Ames, Iowa. (1989).

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	2	2	2	2	2
CO4	2	3	3	3	3
CO5	3	3	3	3	3

SEMESTER: III	TITLE: NANO MATERIAL AND ITS APPLICATIONS	CREDITS: 3
PART: OPEN ELECTIVE II (2)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To create a basic knowledge in nano materials.
LO2	To know the significance of nanomaterials.
LO3	To enable the students to explore the field of nanomaterials.
LO4	To demonstrate the different tools for the characterization of synthesized materials.
LO5	To select the nanomaterials for various applications.

Unit I : Introduction to Nanoscience

Introduction - Need and origin of nano - Top-down and bottom-up approaches - nano structures Definition of - Zero-, one- and two-dimension - Quantum dots - Quantum wire -Quantum well.

Unit II : Nano Materials

Nanomaterials- Classification - C_{60} - Buckminster fullerene - Carbon nanotubes: Structure - Types and Applications - Metal based nanomaterials, Nanocomposites, Nano porous materials and Dendrimers.

Unit III : Fabrication

Chemical Vapour Deposition - Physical Vapour Deposition- spray pyrolysis- lithography technique. Synthesis of oxide nanoparticles by sol-gel method- Electrochemical deposition method- Electrospinning method- Atomic Layer Deposition method (ALD)- Core Shell Structures-Organic and Inorganic Hybrids.

Unit IV : Characterization of Nanomaterials

Principles, experimental set-up, procedure and utility of X-ray Diffraction (XRD) (Single and Powder Crystal)- Scanning electron microscopy (SEM)- Transmission electron microscopy (TEM)- UV-Visible absorption (UV- Vis)-Fourier Transform Infrared spectroscopy (FT-IR) and Photoluminescence (PL).

UNIT V : Applications

Nano energy storage and generation devices- Molecular Electronics and Nanoelectronics -Nanosensors – Catalysts - nanorobots and nano submarines - Nanophotonics - Green nanotechnology - Solar cells.

Course Outcomes:

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

CO1	Comprehend the fundamental concepts of nanomaterials and its properties.
CO2	Expose an idea about nanostructures.
CO3	Improve their knowledge in Synthesis Methods.
CO4	Acquire the knowledge of different characterization of nanoparticles.
CO5	select the nanomaterials for Further Advanced Research Studies.

Text Books :

1. T. Pradeep et al., *A Textbook of Nanoscience and Nanotechnology* (Tata McGraw Hill, New Delhi, 2012).
2. G. Cao, *Nanostructures and Nanomaterials* (Imperial College Press, London, 2004).
3. C.P. Poole and F.J. Owens, *Introduction to Nanotechnology* (Wiley, New Delhi, 2003).
4. Viswanathan B, Nano Materials, Narosa publishing house, 2010.
5. T.Pradeep, Nano - The Essentials, Tata McGraw – Hill publishing company limited, 2007.
6. Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials, 2nd Edison, Imperial College Press in 2004, USA.

Supplementary Readings :

1. 1.Carl.C.Koch, Nanostructured materials, processing, properties and applications,NFL
2. publications, (2007).
3. 2.C.N.R.Rao, P.J.Thomas and U.Kulkarni Nanomaterials: Synthesis, properties and applications, Springer Verlag (2007).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	3
CO2	3	2	2	3	3
CO3	3	3	2	2	3
CO4	3	3	2	3	3
CO5	3	3	2	3	3

SEMESTER: III	TITLE: ANALOG AND DIGITAL ELECTRONICS	CREDITS: 3
PART: OPEN ELECTIVE II (3)	COURSE CODE:	Hours/Week: 3

Learning Objectives

LO1	To introduce the basic active elements in Electronics.
LO2	To make the student to understand operational amplifiers
LO3	To make the student to understand Boolean function
LO4	To make the student to understand digital circuits
LO5	To make the students to understand microprocessor.

UNIT I : Special Diodes

Introduction - Zener Diode - Mechanism of Breakdown - V-I characteristic-Zener voltage Regulator-Tunnel Diode – Photodiode - Light Emitting Diode (LED) – Four layer Diode – Schottky Diode - Silicon Controlled Rectifier (SCR).

UNIT II : Operational Amplifiers

Introduction - Ideal Op Amp - Practical Op Amp - Concept of Virtual Ground - Differential amplifier - Op Amp Parameters - Inverting Op Amp-Non-Inverting op Amp-Op amp adder - Op Amp subtractor - Op Amp Integrator-Op Amp Differentiator-Logarithmic Amplifier-Comparators.

UNIT III : Simplication of Boolean Function

Introduction-Logic gate-The map method-Two-and-Three variable maps-Four variable maps-five and six variable maps-Product of sums simplification-NAND & NOR Implementation - Other two level implementation-Don't care condition-The tabulation method-Determination of Prime implicants-selection of prime implicants.

UNIT IV : Digital Circuits

Introduction-Digital to Analog conversion-parameters of DAC- DAC using BCD input Code-Bipolar DACs-R-2R Ladder type DAC-Weighted Resistor type DAC-Switched current source type DAC- Switched Capacitor type DAC-Counter type A/D Converter-Dual Slope type A/D Converter-Successive Approximation type DAC.

UNIT V : Microprocessor

Introduction- Ideal Microprocessor-Data bus-Address bus – Control bus-Basic operation-Microprocessor Operation- 8085A Microprocessor Architecture-Instruction Set-Data transfer group-Arithmetic group-Logical group-Branch group-Stack I/O and machine control group.

Course outcome

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

CO1	Recognize the concept of Varies diodes
CO2	Describe the application of Op amp
CO3	Recognize the concept of Various Boolean functions
CO4	Understand Digital Circuits and their applications.
CO5	Write programmes using the instruction set of microprocessor 8085.

Text Books :

1. S.L.Kakani & K.C.Bhandari – *A Textbook of Electronics* – New Age International (P) Ltd-New Delhi – Reprint (2018).
2. A.Anand Kumar – *Fundamentals of Digital Circuits* –Third Edition-PHI Learning (P) Ltd., Delhi. (2014).
3. R.P Jain –*Modern Digital Electronics* - Tata McGraw-Hill publishing company Ltd-New Delhi-Third Edition-reprint. (2008).
4. Dr.R.K. Kar, *Eletronics Classical & Modern Books and Allied* (P) Ltd-Kolkata-reprinted. (2011)

Supplement Reading:

1. M. Morries Mano, *Digital Logic & Computer Design,* Prentice Hall of India Pvt. Ltd., New Delhi, 11th Edition, (1995).
2. R.S. Sedha, *A Text Book of Digital Electronics,* S.Chand & Co, New Delhi, 3rd Edition, (2016).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	3
CO2	3	3	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	2	2	2

SEMESTER: IV	TITLE: NUCLEAR AND PARTICLE PHYSICS	CREDITS: 4
PART: CORE COURSE XIV	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	Understand the fundamental principles and concepts governing nuclear and particle Physics.
LO2	Realize the nuclear structure and nuclear forces through various theories.
LO3	Analyze the theories involved in radioactive decays
LO4	Learn about nuclear fission and fusion reactions.
LO5	Gain knowledge in elementary particles based on theoretical models.

Unit I: Nuclear Properties and Nuclear Forces

Characteristics of Nucleus Forces – Exchange forces and tensor forces – charge independence-Spin dependence of Nucleus Forces - Meson theory of nuclear forces- Ground state of deuteron-Nucleon-nucleon scattering singlet and triplet parameters – Nucleon-Nucleon scattering: Cross-section, Differential Cross-section, Scattering Cross-sections – magnetic moment- Quadrupole moment –S and D state admixtures - Effective range theory of n-p scattering at low energies.

Unit II: Nuclear Models

Binding energy & mass defect – Weizacker's formula – mass parabola - Liquid drop model -Bohr -Wheeler theory of fission- Activation energy for fission- Shell model- Spin –Orbit coupling-Spins of nuclei- Magnetic moments – Schmidt lines- Electric quadrupole moments - Collective model of Bohr and Mottelson: Nuclear vibration – Nuclear rotation –Nelson model.

Unit III: Nuclear Reactions

Nuclear reaction - Q- value – Nuclear reaction cross section – Direct Nuclear Reactions: Knock out reaction, Pick-up reaction, Stripping reaction – Compound nucleus theory – Formation –Disintegration energy levels – Partial wave analysis of Nuclear reaction cross-section -– Scattering matrix - Reciprocity theorem – Breit -Wigner one level formula

Unit IV: Radioactive Decays

Alpha decay - Beta decay –Energy release in beta decay – Fermi theory of beta decay – Shape of the beta spectrum – decay rate Fermi-Curie plot – Fermi & G.T Selection rules - Comparatives half - lives and forbidden decays- Gama decay - Multipole radation – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.

Unit V: Elementary Particle Physics

Classification of elementary particles - Types of interaction between elementary particles – Hadrons and leptons – Symmetry and conservation laws – Strangeness and associate production - CPT theorem – classification of hadrons – Quark model - Isospin multiples - SU(2)- SU(3) multiplets- Gell-Mann - Okubo mass formula for octet and decuplet hadrons – Phenomenology of weak interaction hadrons and leptons - Universal Fermi interaction – Elementary concepts of weak interactions.

Course Outcomes:

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

CO1	Summarize the nuclear interactions through nucleon scattering theories.
CO2	Gain knowledge in various types of nuclear reactions.
CO3	Discuss the theories involved in different types of radioactive decays.
CO4	Explain the nuclear fission and fusion reactions and their applications.
CO5	Describe elementary particles and discuss their classifications based on theoretical models.

Text Books :

1. Concepts of Nuclear Physics, B. B. Cohen, TMGH, Bombay, 1971.
2. Introductory Nuclear Physics, K. Krane, Wiley, New York, 1987.
3. Nuclear Physics, V. Devanathan, Narosa Publishing house.
4. Introduction to Elementary Particles, D. Griffiths, 2nd Ed., Wiley-Vch, 2008
5. Nuclear Physics, S.N. Ghoshal, S. Chand and Co., II edition, 1994.
6. Nuclear Physics, D.C. Tayal, Himalaya Publishing House Pvt., Ltd., V edition, 2018.

Supplement Reading:

1. R. D. Evans, "Atomic Nucleus", Mcgraw-Hill NY.1955.
2. J. M. Blatt and V. F. Weisskopf, "Theoretical Nuclear Physics". Berlin 1979.
3. H. Enge, " Introduction to Nuclear Physics Addision-Wesley" .Reading MA. 1975
4. R. R. Roy and B. P. Nigam, "Nuclear Physics", Wiley Eastern, Madras1993.
5. D.C. Tayal „Nuclear Physics"
6. A. Bohr and B. R. Mottelson, "Nuclear Structure" Vol. I (1969) and Vol.II(1975), Benjamin Reading .

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	3
CO2	3	3	3	2	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	3	2	2	2

SEMESTER: IV	TITLE: SPECTROSCOPY	CREDITS: 4
PART: CORE COURSE XIV	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To understand the basics of Atomic Spectroscopy and the interaction of matter and energy.
LO2	To familiarize with the basic principles of Microwave and absorption spectroscopic techniques and their applications.
LO3	To introduce Raman Spectroscopy and learn the determination of atomic structure, chemical composition and physical properties of materials from Raman Spectrum.
LO4	To know the basics and applications of Nuclear Magnetic Resonance and Nuclear Quadrupole Resonance spectroscopies.
LO5	To learn the principles of ESR and Massbauer Spectroscopies

Unit I-Atomic Spectroscopy

Quantum states of electron in atoms-Hydrogen atom spectrum-Electron spin-Stern – Gerlach experiment-spin –orbit interaction-Two electron systems-LS-JJ coupling schemes-fine structure-Spectroscopic terms and selection rules-Hyperfine structure –Exchange symmetry of wave functions-Pauli's exclusion principle-Periodic table-Alkali type spectra-Equivalent electron-Hund's rule.

Unit-II Microwave Spectroscopy

Rotation of Molecules – Rigid Rotor (Diatomic Molecules) – Expression for the Rotational Constant - Intensity of Spectral Lines – Effect of Isotopic Substitution - Molecular Parameters (Bond Length, Bond Angle, Dipole Moment) from Rotation Spectra – Techniques and Instrumentation.

Unit III: Infrared Spectroscopy

Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator- Vibrations of polyatomic molecules-Fermi resonance-Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal vibrational spectra-Group frequencies-IR spectrophotometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications

Unit IV: Raman Spectroscopy

Introduction-Theory of Raman scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual Exclusion principle-Raman spectrometer-Sample handling techniques-Polarization of Raman scattered light-Structure determination using IR and Raman spectroscopy-Raman investigation of phase transitions-Resonance Raman scattering-Nonlinear Raman phenomena-Preliminaries-Hyper Raman effect-Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering.

UnitV:Nuclear Magnetic and Electron Spin Resonance Spectroscopy

Basic principles – Quantum theory of NMR - magnetic resonance – relaxation processes – chemical shifts – spin-spin coupling - Spectra and molecular structure – Fourier Transform NMR –Instrumentation – Applications. – ESR spectrometer – Instrumentation –applications.

Basic theory - Nuclear Electric quadrupole interaction – Energy levels – Transition frequency –Excitation and Detection – Effect of magnetic field – Instrumentation – applications. Mossbauer effect - recoilless emission and absorption - hyperfine interaction - chemical isomer shift - magnetic hyperfine and electric quadruple interactions – ` Instrumentation – applications.

Course Outcomes:

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

CO1	Understand the basics of Atomic Spectroscopy and the interaction of matter and energy.
CO2	Know the basic principles of Microwave and absorption spectroscopic techniques and their applications.
CO3	Apply Raman Spectroscopy in the determination of atomic structure, chemical composition and physical properties of materials from Raman Spectrum.
CO4	Know the basics and applications of Nuclear Magnetic Resonance and Nuclear Quadrupole Resonance spectroscopies.
CO5	Understand the principles of ESR and Massbauer Spectroscopies

Text Books:

1. C.N. Banwell, *Fundamentals of Molecular Spectroscopy* McGraw Hill, New York (1981).
2. G. Aruldhas, *Molecular Structure and Spectroscopy* Prentice Hall, New Delhi. (2006).
3. D.N. Sathyanarayana, *Vibrational Spectroscopy* New Age International, New Delhi (2015).
4. Gupta Kumar Sharma, *Elements of spectroscopy* Pragati Prakashan, Meerut. (2003)

Supplementary Readings:

5. J. Michael Hollas, *Modern Spectroscopy* Wiley India, New Delhi. (2004).
6. B.P. Straughan and S. Walker, *Spectroscopy Volumes I--III* Chapman and Hall, New York. (1976).

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	2
CO2	3	3	3	2	3
CO3	3	3	2	2	3
CO4	3	2	2	2	2
CO5	3	2	2	3	3

SEMESTER: III	TITLE: ELECTRONICS	CREDITS: 4
PART: CORE COURSE XII	COURSE CODE:	Hours/Week: 5

Learning Objectives

LO1	To make the students to understand experimental physics
LO2	To apply the theoretical knowledge for developing new devices
LO3	To study the aspects related to the application side of the experiments
LO4	To provide a hands-on learning experience and understand the basic concepts

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LIST OF EXPERIMENTS
(Any Twelve Experiments)

1. Verification of Half adder and fulladder
2. Digital to analog converter — R-2R and weighted method
3. Study of frequency multiplexer using PLL
4. Digital comparator using XOR and NAND gates
5. Study of Hall effect
6. Four bit binary up and down counter using IC 7473
7. BCD to 7 segment display
8. Study of RAM
9. Study of full subtractor and half subtractor
10. Study of Arithmetic Logic Unit (ALU) - IC 74181
11. Construction and study of characteristics of Chua's diode
12. Constuction of multiplexer and De multiplexer
13. Construction of memristor
14. Verification of Demorgan's theorem and Boolean expressions
15. Voltage controlled oscillator using IC 555
16. Microwave IC - Filter Characteristics
17. Characteristics of a voltage dependent resistor (VDR)
18. Transmission characteristics of optical fiber link
19. Design of AC/DC voltage regulator using SCR
20. Construct Universal gates using NAND and NOR

Text books:

1. C.C. Ouseph, U.J.Rao, V. Vijayendran, *Practical Physics and electronic*, Ananda book Depot, Chennai (2018).

2. M.N.Srinivasan, S.Balasubramanian ,R.Ranganathan, *A Text book of Pratical Physics*, Sultan Chand & Sons, New Delhi.(2015)

Supplementary Readings:

1. Samir Kumar Ghosh, *A Text book of Advanced Pratical Physics*, NCBA, Kolkatta.(2000).
2. D. Chattopadyay, P.C Rakshit, An Advanced Course in Pratical Physics, NCBA, Kolkatta.(2000).

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	2	2
CO2	3	3	3	2	3
CO3	2	3	3	2	2
CO4	3	3	3	2	3
CO5	2	3	3	2	2

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SEMESTER: IV	TITLE: NANOTECHNOLOGY AND THIN FILMS	CREDITS: 4
PART:ELECTIVE COURSE III (1)	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To create a basic knowledge in nano materials.
LO2	To know the significance of nanomaterials.
LO3	To enable the students to explore the field of nanomaterials.
LO4	To demonstrate the different tools for the characterization of synthesized materials.
LO5	To Know the basic about thin films

Unit I: Introduction to Nano and Types of Nanomaterials

Need and origin of nano -- Nano and energetic – Top-down and bottom-up approaches Introductory ideas of 1D, 2D and 3D nanostructured materials – Quantum dots -- Quantum wire Quantum well -- Exciton confinement in quantum dots. Carbon nanotubes: Fabrication – Structure – Electrical properties –Vibrational properties – Mechanical properties – Applications (fuel cells, chemical sensors.

Unit II: Fabrication of Nanomaterials

Synthesis of oxide nanoparticles by sol-gel method -- Electrochemical deposition method –Electrospinning method – Lithography -- Atomic layer deposition - Langmuir--Blodgett films --Zeolite cages -- Core shell structures – Organic and inorganic hybrids.

Unit III:Application of Nanomaterial

Nano electronics-Molecular electronics-Nano photonics-Nano robotics –Nano mechanics-Band gap engineered quantum devices-Photo electrio chemical cells-Plasmonic wave guide-CNT emitters-Gold nano particles in catalysis- Bio medical applications

Unit IV : Thin Film Deposition Techniques

Thin Films - Deposition Techniques - Physical Methods -Resistive Heating, Electron Beam Gun, Laser Gun Evaporation and Flash Evaporations - Sputtering -Reactive Sputtering. Chemical Methods - Spray Pyrolysis - Preparation of Transparent Conducting Oxides.

Unit V: Characterization Technique

X - Ray Diffraction (XRD) - Powder and single crystal – SEM - TEM – SPM – AFM – UV, FTIR – Photoluminisence - Elemental analysis - EDX - Atomic absorption spectroscopy - Thickness determination. Formation of fringes, Gravimetric method and Thermal Characteristics. - Thermo Gravimetric Analysis (TGA) - Differential Thermal Analysis (DTA) - Differential Scanning Calorimetry (DSC).

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

CO1	create a basic knowledge in nano materials.
CO2	know the significance of nanomaterials.
CO3	enable the students to explore the field of nanomaterials.
CO4	demonstrate the different tools for the characterization of synthesized materials.
CO5	Know the basic about thin films

Text Books:

1. Ragavan J.C. Brice, Crystal Growth Processes, John Wiley and Sons, New York (1986).
2. P. Santhana and P. Ramasamy, Crystal Growth Processes and Methods, KRU Publications, Kurnbakonam (2001).
3. Goswami, Thin Film Fundamentals, New Age International (P) Limited, New Delhi (1996).

Supplementary Readings:

1. H.H. Witlard, L.L. Merritt, J A. Dean, F.A. Settle, CBS, Publishers and Distributors, New Delhi.

COURSE OUTCOME MAPPING

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	2	2
CO2	3	3	3	2	3
CO3	3	3	2	2	3
CO4	3	2	2	2	2
CO5	3	2	2	3	3

SEMESTER: IV	TITLE: ENERGY PHYSICS	CREDITS: 4
PART:ELECTIVE COURSE III (2)	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To develop knowledge about energy source
LO2	To know about renewable energy in detail
LO3	To develop knowledge in energy from biomass
LO4	To know about the solar energy
LO5	To discuss about additional energy sources

Unit - I: Energy Source

Introduction to energy source - Energy sources and their availability - Types of energy -Prospects of renewable energy - Extraterrestrial solar radiation - Effect of earth's atmosphere - Measurement and estimation of solar radiation.

Unit – II: Renewable Energy

Wind energy – basic principle and components of wind energy conversion system - types of wind machines – scheme of electric generation – application of wind energy – Hydrogen energy-hydrogen production – storage – utilization of hydrogen gas – hydrogen as an alternative fuel for motor vehicles – safety and management.

Unit – III: Energy From Biomass

Biomass conversion Technologies – wet and dry process – Photosynthesis. Biogas Generation: Introduction – basic process and energetic – methods for maintaining biogas production –advantage of anaerobic digestion – factors affecting bio digestion and generation of gas. Classification of Biogas plants: continuous and batch type – the dome and drum types of Biogas gas plants – biogas from wastes fuel – properties of biogas – utilization of biogas.

Unit - IV: Solar Energy

Solar cells for direct conversion of solar energy to electric powers - Solar cell parameter –Solar cell electrical characteristics – Efficiency – Single crystal silicon solar cells –Polycrystalline silicon solar cells – Cadmium sulphide solar cells. Applications of Solar Energy: solar distillation-solar water heating-solar pumping - solar furnace-solar cooking-solar green house.

Unit – V: Additional Alternate Energy Sources

Introduction and principles of Magneto hydro dynamic(MHD) – open and closed cycle systems – materials for MHD generators –MHD design problems and developments – electrical conditions – advantages of MHD systems.

Text Books:

1. D.P. Kothari, K.C. Singal & Rakesh Ranjan, Renewable energy sources and emerging Technologies, Prentice Hall of India Pvt. Ltd., New Delhi (2008).
2. Suhas P Sukhatme, Solar energy- Principles of thermal collection and storage, Tata McGraw-Hill Publishing company, New Delhi, Second edition, 2012.

Supplementary Readings:

1. Renewable Energy Resources - John Twidell & Tony Weir, Taylor & Francis Group, 2006.
2. Principles of Solar Engineering - Kreith and Kreider, McGraw Hill Pub, 1978.
3. Applied Solar Energy - A.B.Meinel and A.P.Meinal, 1976.
4. Solar Energy - M.P.Agarwal, S.Chand & Co, 1983.
5. Solar Energy - S.P.Sukhatme, TMH, 1996.
6. Non-conventional Energy sources - G.D.Rai, Khauna Publication, 2004

Course Outcome Mapping:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	3	2
CO2	3	2	2	3	3
CO3	2	2	2	3	2
CO4	3	2	2	2	2
CO5	2	2	2	3	2

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SEMESTER: IV	TITLE: RADIOLOGICAL SAFETY ASPECTS	CREDITS: 4
PART:ELECTIVE COURSE III (3)	COURSE CODE:	Hours/Week: 6

Learning Objectives

LO1	To create a basic knowledge Radioactivity.
LO2	To know the significance of Detectors
LO3	To enable the students to explore the field of hazards evaluation & control
LO4	To demonstrate the different regulatory aspects & waste disposal
LO5	To Know the basic about Transport of radioisotopes

UNIT-I: Radiation Physics

Introduction to Radioactivity – Radioactive disintegration – Properties of nuclear radiation –Decay & half-life – type of decay - Interaction of Ionizing radiation with Matter – interaction of charge particles – Electromagnetic interactions – Photoelectric absorption – Compton scattering -Attenuation of Gamma radiation in matter – Biological effects: Radiation damage - Molecular level & Cellular level – Deterministic effects – Stochastic effects.

UNIT-II: Radiation Detection

Detectors & Monitoring Instruments: Gas Filled Detectors: GM counter & Proportional Counter Scintillation Detectors – Semiconductor Detectors - Radiation survey meters – Beta & Gamma detection - Neutron detector - Thermo-Luminescent dosimeters.

UNIT-III: Principles Of Radiological Protection, Hazards Evaluation & Control

Radiation Quantities and Units - Dose, equivalent dose and effective dose – ALI & DAC Radiological protection – Optimization of protection – Dose limits for radiation workers –internal exposure, Occupational exposure and members of public - Occupational exposure levels Radiation hazards evaluation - Specific Gamma constant - Principles to control external hazards - Radiation shield – half-value thickness – Tenth value thickness.

UNIT-IV: Regulatory Aspects & Waste Disposal

Regulatory document - Monitoring of external radiation - Area monitoring – Role of Radiological Safety Officers - Emergency procedures and spill control - Radioactive Waste management - Types of radioactive waste - Classification of radioactive waste - Disposal of radioactive waste – Solid - Liquid.

UNIT-V: Planning Of Isotope Laboratories & Transport Of Isotopes

Calcification Of Radioisotopes – Types Of Radioisotope Laboratories – Design Of Radioisotope Lab. -Specifications & Requirements - Types Of Operations – Transport Of Radioisotopes – Condition For Transport – Selection Of Package & Design Requirements – Types Of Package - Safety Aspects Of Transport.

Text books

1. Glenn F. Knoll 'Radiation Detection and Measurement', John wiley& sons Inc.
2. K. Muraleedhara varier, 'Nuclear radiation detection, measurements and analysis' Narosa.
3. S. S. Kapoor and V.S. Ramamurthy- 'Nuclear Radiation Detectors', Wiley Eastern Ltd.

Supplementary readings

1. Govinda Rajan, Advanced Medical Radiation Dosimetry, Prentice hall of India Pvt.Ltd., New Delhi, 1992.
2. AERB Radiation Production Rules 2004

Course Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	2
CO2	3	2	2	3	3
CO3	2	2	2	3	2
CO4	3	2	2	2	2
CO5	2	2	2	3	2

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