Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

DIT UNIVERSITY
Dehradun

Detailed Course Structure
of

M.Sc. Physics

Approved by the Academic Council at its 9th Meeting held on 14.04.2018

Department of Physics
Course Structure of M.Sc. Physics
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Course Structure

Year: 1st **Semester: I**

Course Category	Course Code	Course Title	L	T	P	Credit
CC	PY606	Mathematical Physics	4	0	0	4
CC	PY607	Classical Mechanics	4	0	0	4
CC	PY608	Quantum Mechanics	4	0	0	4
CC	PY609	Statistical Mechanics	4	0	0	4
GEC	CS105	Programming for Problem Solving	3	0	4	5
CC	PY616	Physics Lab-1	0	0	6	3
		Total	**19**	**0**	**10**	**24**

Year: 1st **Semester: II**

Course Category	Course Code	Course Title	L	T	P	Credit
CC	PY617	Condensed Matter Physics	4	0	0	4
CC	PY618	Electrodynamics	4	0	0	4
CC	PY619	Basic Electronics	4	0	0	4
CC	PY626	Atomic and Molecular Physics	4	0	0	4
CC	PY627	Nuclear and Particle Physics	4	0	0	4
CC	PY628	Physics Lab II	0	0	6	3
		Total	**20**	**0**	**6**	**23**

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Course Structure

Year: 2nd **Semester: III**

Course Category	Course Code	Course Title	L	T	P	Credit
CC	PY706	Physics of Semiconductor Devices	4	0	0	4
CC	PY707	Analog Electronics	4	0	0	4
CC	PY709	Measurement Techniques in Physics	4	0	0	4
DSE	PY7**	Elective-I	4	0	0	4
CC	PY716	Physics Lab-III	0	0	6	3
SEM	PY717	Seminar	0	0	4	2
		Total	**16**	**0**	**10**	**21**

Elective-I

Physics of Lasers and Applications	PY746
Science and Technology of Renewable Energy Sources	PY747
Microprocessor and Applications	PY748

Year: 2nd **Semester: IV**

Course Category	Course Code	Course Title	L	T	P	Credit
GEC	MA748	Computational Techniques and Programming	3	0	2	4
DSE	PY7**	Elective-II	4	0	0	4
AEC	MB604	Organizational Behaviour	3	0	0	3
PJCT	PY718	Project	0	0	16	8
		Total	**10**	**0**	**18**	**19**

Elective-II

Digital Electronics	PY746	PY756
Nano Electronics	PY747	PY757
Optoelectronics	PY748	PY758

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Summary of the Credit

Year	Semester	Max Credit
1	1	24
	2	23
2	3	21
	4	19
Total		**87**

Category wise classification of the Credit

Category		**Credit**	**Number of Subjects**
CC	Departmental Core Course	57	15
GEC	Generic Elective Course	9	2
AEC	Ability Enhancement Course	3	1
DSE	Discipline Specific Course	8	2
PRJT/THESIS	Project	8	1
SEM	Seminar	2	1
Total		**87**	**22**

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Subject Code	PY 606	Subject Title	Mathematical Physics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	**1st**	**Semester**	I

Course Outline:

The course covers an introduction to complex variables, partial differentiation, Fourier Series and transforms, special functions and probability and statistics.

Course Objective:
The objective of the course on Mathematical Physics-I is to equip the M.Sc. students with the mathematical techniques that he/she would for understanding and handling theoretical treatments in different courses taught in the MSc program and for developing a strong background if he/she chooses to pursue research in physics as a career.

Course Pre/Co- requisite (if any) : no essential pre-requisite

Detailed Syllabus

UNIT 1

Complex Variables: Introduction, Analytic function, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, Singularities, Calculus of residues, Evaluation of definite integrals. 8 L

UNIT 2

Partial Differential Equations: Partial differential equations, Separation of variables. One dimensional wave and heat equation, two dimensional heat equation and Laplace equation.

Fourier Series and Fourier Transforms: Fourier series, Dirichlet conditions. General properties. Advantages and applications, Gibbs phenomenon, Fourier transforms, Development of the Fourier integral, Fourier transforms of derivatives. Momentum representation. 12 L

UNIT 3

Special Function: Series Solution, Bessel functions of first and second kind, Generating function, Integral representation and recurrence relations for Bessel's functions of first kind, orthogonality; Legendre functions: generating function, Recurrence relations and special properties, Orthogonality; Legendre polynomials: recurrence relations, Parity and orthogonality, Hermite functions, Laguerre functions. 10 L

UNIT 4

Statistics and Probability: Moments, moment generating functions, skewness, Kurtosis, correlation and regression, binomial distribution, Poisson distribution, normal distribution.

Tensors. Introductory group theory: SU(2), O(3). 10 L

Learning Outcome

1. Understand the use of complex variables for solving definite integral.
2. Understand and use the Delta and Gamma functions for describing physical systems
3. Solve partial differential equations using boundary value problems
4. Understand special functions to solve the physics problems
5. Use statistical methods to analysis the experimental data

Text book [TB]:

1. Boas M.L. Mathematical Methods in the Physical Sciences, John Wiley & Sons, NewYork (1983).
2. Harper C. Analytical Mathematics in Physics, Prentice Hall (1999).

Reference books [RB]:

1. Arfken G. and Weber H.J., Mathematical Methods for Physicists, Academic Press (2005).
2. Rajput B. S., Mathematical Physics, PragatiPrakashan (2002).

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Subject Code	PY 607	Subject Title	Classical Mechanics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1^{st}	**Semester**	I

Course Outline:

The course covers Newtonian mechanics of one and many particle system, Hamiltonian problems, Central force and rigid body dynamics, and canonical transformations.

Course Objective:
The aim and objective of the course on Classical Mechanics is to train the students of M.Sc. in Lagrangian and Hamiltonian formalisms of mechanics for applications in the modern branches of physics such as Quantum Mechanics, Quantum Field Theory, Condensed Matter Physics, Astrophysics, etc.

Course Pre/Co- requisite (if any) : no restricted pre-requisite

Detailed Syllabus

UNIT 1
Newtonian Mechanics of one and many particle system; conservation of linear and angular momentum, work energy theorem, Centre of mass and laboratory coordinates, Galilean transformation, Intertial and non-inertial frames, Rotating frames, Centrifugal and Coriolis forces 10 L

UNIT 2
System of Particles: Constraints, D'Alembert principle, Principle of virtual work, Degree of freedom, generalized coordinate and momenta, Lagrange's equation and application of linear harmonic oscillator, Simple pendulum and central force problems, Cyclic coordinate, Symmetries and conservation laws. Hamiltonian, Lagrange's equation from Hamilton's principle, Principle of least action derivation of equation of motion; variation and end points 10 L

UNIT 3
Central Force: Reduction of two body problem into single body problem. Definition and characteristics of central force; Closure and stability of circular orbits. General analysis of orbits: bounded and unbounded orbits, Kepler's law of motion, Scattering in centre of mass and laboratory frame of reference, Rutherford scattering.
Rigid Body Dynamics: Eulerian angle, Inertia tensor, principal moment of inertia. Euler's equation of motion of a rigid body, Force free motion of a symmetrical top. 10 L

UNIT 4
Canonical Transformation: Canonical transformation, Legendre Transformation, Generating functions. Conditions for a transformation to be canonical, Hamilton-Jacobi equation, Hamilton's principle and characteristics functions, Action and action angle variables, Poisson bracket (PBs) and its properties, Angular momentum PBs.
Wave Motion: Small oscillations, Normal modes and normal coordinates. Examples: Two coupled pendulum and Vibration of linear triatomic molecule, Dispersion relation. 10 L

Learning Outcome

1. The concepts of motion of system of particles and associated frames of references
2. Use variational principle and generalised coordinates based on degrees of freedom
3. Be competent in understanding scattering problems and frame transformations
4. Use of canonical transformations for deriving equations
5. Develop ideas of small harmonic oscillations applicable to systems of interest

Text book [TB]:

1. Gupta K.C., "Classical Mechanics of particles and Rigid Bodies", Wiley Eastern (2001).
2. Goldstein H., Classiacal Mechanics, Pearson Education Asia Pte Ltd. House (2002).

Reference books [RB]:

3. Rana N. C and Joag P S, Classical Mechanics, Tata McGraw-Hill (1991).

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Subject Code	PY 608	**Subject Title**	Quantum Mechanics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	I

Course Outline:

The course starts with an introduction to quantum mechanics, and it covers operator algebra, solution of schrodinger wave equation for different potential functions, approximation methods and perturbation theory.

Course Objective:

The aim and objective of the course on Quantum Mechanics is to introduce the students of M.Sc. class to the formal structure of the subject and to equip them with the techniques of vector spaces, angular momentum, perturbation theory, and scattering theory so that they can use these in various branches of physics as per their requirement.

Course Pre/Co- requisite (if any) :it is desired that the student have studied modern physics at undergraduate level.

Detailed Syllabus

UNIT 1

Introduction to Quantum mechanics: Inadequacy of classical Physics and Postulates of Quantum Mechanics, Wave particle duality and uncertainty principle, Complimentary principle.
Operator Algebra: Operator method, Commutators, Eigen values, Eigen functions and their orthogonality, Hermitian operator, Parity operator, Projection operator; Unitary operator; Representation of state vectors, Change of basis, Unitary Transform, Bra and Ket notation 6 L

UNIT 2

Schrodinger wave equation: Development of wave equation, Schrodinger's time dependent and independent wave equation, Interpretation and normalization of wave function, Probability current density, Expectation value and Ehrenfest theorem. Wave packets, Momentum eigen functions, Box normalization and delta function normalization.
Solution of Schrodinger's equation: Sectionally constant potential in one dimension: Potential Step, Rectangular Potential Barrier and tunneling, The square potential well. Potential with bounded states: Linear Harmonic Oscillator, Rigid Rotator and Hydrogen atom. 12 L

UNIT 3

Angular momentum in Quantum mechanics: General solution to the eigen value problem of angular momentum J and the angular momentum and spin matrices, Eigenvectors for spin ½ particles, Addition of two angular momenta, ClebschGordan coefficient, System of identical particles,
Indistinguishability principle, Symmetry of wave functions, Spin statistics.
Perturbation theory: Time independent perturbation theory and application to Non degenerate and degenerate case, Time dependent perturbation theory and application to the equation of motion in interaction picture, Transition probability And Fermi-Golden Rule, Selection Rules. 12 L

UNIT 4

Approximation Methods: Variational and WKB Approximation, The connection Formula, Tunneling through a barrier.
Introduction to theory of Scattering: Total and Differential Scattering cross section, Partial wave and Phase shift, Optical Theorem, Born approximation and scattering by One dimensional Potential barrier, Spherically symmetric potential and Coulomb Field. 10 L

Learning Outcome

1. Understand the need for quantum mechanical formalism and basic principles
2. Gain exposure and appreciate the importance and implication of vector spaces, diracket bra notations, eigen value problems, generalized uncertainty principle in quantum mechanics.
3. Better understanding of the mathematical foundations of angular momentum of a system of particles
4. Applications of various approximation methods in solving the Schrodinger equation
5. Apply the perturbation theory to scattering matrix and partial wave analysis

Text book [TB]:

1. Thankapan ,Quantum Mechanics, New Age Int. Ltd (2004).

Reference books [RB]:

1. Schiff L. I., Quantum Mechanics, McGraw-Hill (2008)
2. Ghatak&Loknathan, Quantum Mechanics, MacMillan India Ltd (2004).

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Subject Code	PY 609	**Subject Title**	Statistical Mechanics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	I

Course Outline:

The course covers classical statistical mechanics and ensemble theory, quantum statistics, Bose and Fermi systems, phase transitions and critical phenomenon

Course Objective:
The aim and objective of the course on Statistical Mechanics is to equip the M.Sc. student with the techniques of Ensemble theory so that he/she can use these to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents and properties.

Course Pre/Co- requisite (if any) :no pre-requisite

Detailed Syllabus

UNIT 1
Classical Statistical Mechanics and Ensemble Theory: The macro and microstates, contaction between statistics and thermodynamics, classical ideal gas, Gibbs paradox and its solution. Phase space and Liouville's Theorem, The microcanonical ensemble theory and its application to ideal gas of monatomic particles, Partition function, Classical ideal gas in canonical ensemble theory, Energy fluctuations, Equipartition and virial theorems, A system of harmonic oscillators as canonical ensemble, Thermodynamics of magnetic systems and negative temperatures, The grand canonical ensemble and significance of statistical quantities. Classical ideal gas in grand canonical ensemble theory.Density and energy fluctuations. **10** L

UNIT 2
Quantum Statistics: Quantum states and phase space, The density matrix, Canonical density matrices for a particle in a box and a linear oscillator, Quantum statistics of various
ensembles. An ideal gas in quantum mechanical ensembles, statistics of occupation numbers 10 L

UNIT 3
Ideal Bose and Fermi Systems: Basic concepts and thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation, Discussion of gas of photons (the radiation fields) and phonons (The Debye field), Liquid helium and super fluidity.
Thermodynamic behavior of an ideal Fermi gas, Discussion of heat capacity of a free-electron gas at low temperatures, Pauli paramagnetism. 10 L

UNIT 4
Phase Transitions and Critical Phenomenon: Order parameter, Ist and IInd order phase transitions, Ising model in zeroth and first approximation, Crititcalexpoments, thermodynamic inequalities, Landau theory of phase transitions. 10 L

Learning Outcome
1. Understand Equations of state and thermodynamic potentials for elementary systems of particles.
2. Gain perspectives of equilibrium and non-equilibrium statistical Physics.
3. Describe the features and examples of Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac statistics
4. Work with various models of phase transitions and fluctuations pertaining to thermodynamics
5. Describe physical quantities in quantum systems

Text book [TB]:

1. Reif F., Fundamentals of Statistical and Thermal Physics, McGraw Hill (1985).

Reference books [RB]:

1. Pathria R.K., Statistical Mechanics, Butterworth-Heinemann (1996).

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Subject Code	CS105	Subject Title	Programming for Problem Solving						
LTP	3 0 4	Credit	5	Subject Category	GEC	Year	1st	Semester	I

OBJECTIVE:

The objective of the course is to make the students to understand the key hardware components in a modern computer system and as to how the software is mapped to the hardware. The student shall also be able to learn make the computer programs using C language by exploring the various features of C.

Unit 1: Introduction to Computer, Programming & algorithms

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples, From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. 8 L

Unit 2: Arithmetic Expression, and Conditional statements, Loops

Expression:

Arithmetic, Logical, Relational expressions and precedence

Loops & Branching: Writing and evaluation of conditionals and consequent branching, Iteration and loops. 8 L

Unit 3 Arrays & Functions

Arrays: Arrays (1-D, 2-D), Character arrays and Strings.

Functions: functions (including using built in libraries), Parameter passing in functions, call by value, passing arrays to functions: idea of call by reference.

Searching & Sorting: Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required). 9 L

Unit-4 Recursion & Structure

Recursion:

Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.

Structure :

Structures, Defining structures and Array of Structures. 7 L

Unit- 5:Pointers & File handling

Pointers: Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list.

Sorting: Bubble sort, Insertion sort, Selection sort, Quick sort, Merge sort, Heap Sort.

File handling: different modes of opening a file in C, reading, writing from files **7 L**

COURSE OUTCOME:

At the end of the course the student will learn:

CO1. To formulate simple algorithms for arithmetic and logical problems.

CO2. To implement conditional branching, iteration and recursion.

CO3. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.

CO4. To use arrays, pointers and structures to formulate algorithms and programs.

CO5. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.

TEXT BOOKS

1. Byron Gottfried, “Schaum's Outline of Programming with C”, 2nd edition 2006 McGraw-Hill.

2. E. Balaguruswamy, "Programming in ANSI C", 6th Edition 2010, Tata McGraw-Hill.

REFERENCES

1. Brian W. Kernighan and Dennis M. Ritchie, "The C Programming Language", 2nd edition 1988, Prentice Hall of India.

SR.NO.	EXPERIMENT NAME
1	Familiarization with programming environment.
2	Programming for Simple computational problems using arithmetic expressions.
3	Programming for Problems involving if-then-else structures.
4	Programming for Iterative problems e.g., sum of series.
5	Programming for 1-D Array manipulation.
6	Programming for Matrix problems, String operations.
7	Programming for Simple functions
8	Programming for Recursive functions.
9	Programming for Pointers and structures.
10	Programming for File operations
11	Programming for solving Numerical methods problems

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Subject Code	PY 616	Subject Title	Laboratory1 /Practical Course						
LTP	0 0 6	Credit	3	Subject Category	CC	Year	1st	Semester	I

Course Outline:

This laboratory course covers the experiments based on semiconductor materials, magnetism, electron charge and mass ratio, characteristics of photocell, capacitance characteristics, dielectric properties and diode characteristics.

Course Objective:

The course aims to develop experimental skills in students as well as analysis of different results.

Course Pre/Co- requisite (if any) : no essential pre-requisite

Detailed Syllabus

1. To determine the band gap of given semiconductor crystal using four probe method
2. Draw the BH loop of ferrite material and determine the remanance and coercive fields.
3. To determine the value of e/m i.e. specific charge for an electron by Helical Method.
4. Frank hertz experiment
5. Measurement of thickness of thin wire with Laser
6. Study the input and output characteristics of a differential amplifier.
7. To study the characteristics of a Photovoltaic cell (p-n junction solar cell)
   a. The illumination characteristics
   b. The I-V characteristics
   c. Power-load characteristics
   d. Areal characteristics
   e. Spectral characteristics
8. To find Flashing and Quenching voltage of Neon gas and determine the capacitance of a unknown capacitor.
9. To measure the dielectric constant of Liquid/ Glass/PZT.
10. To study the characteristics of Zener diode

Learning Outcome

1. Determine physical characteristics of substances
2. Measure and analyse various types of transport phenomenon
3. Characterization of solid substances using their optical properties
4. To determine fundamental properties of matter using classical experiments
5. To classify matter based on their magnetic and dielectric properties

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Subject Code	PY 617	**Subject Title**	Condensed Matter Physics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	II

Course Outline:
The course covers Physics of crystalline solids, diffraction studies, lattice and phonon vibrations, thermal properties of solids, dielectric materials, magnetism and superconductivity.

Course Objective:
To study the structure and some of the basic properties of the condensed phase of materials especially solids.

Course Pre/Co- requisite (if any) : Its desired that the student have studied solid state physics at undergraduate level

Detailed Syllabus

UNIT 1
Crystal and Non-crystalline Materials: Fundamental types of lattices-two- and three-dimensional lattice types, SC, BCC and FCC unit cells, Packing fractions, Miller indices, Reciprocal lattice vectors, Diffraction of x-rays by crystals, Diffraction conditions, Laue equations, Structure factor and Atomic form factors.
Non-crystalline solids-diffraction pattern, Elementry idea of glass transition, Quasi crystals, Liquid crystals-idea of orientational order and Landau theory of isotropoic-nematic phase transition, Physics of polymers. 10 L

UNIT 2
Lattice Vibrations and Thermal Properties: Vibration of lattice with monoatomic and diatomic basis: Dispersion relation, optical and acoustical branches. Quantization of elastic waves: Phonon, Classical theory of Specific heat. Phonon Density of states.Einstein and Debye models of specific heat.Electronic contributon to the specific heat.
Concept of Energy Band: Nearly free electron model and origin of energy gap, magnitude of gap, Bloch function, Kroning - Penny model, Classification of metal, insulator and semiconductors. Wave equation of electron in periodic potential, Bloch theorem and crystal momentum, Kronning-Penny model in reciprocal space, Brillouin zones, Aproximation: Empty lattice and near zone boundary, Reduced zone, periodic zone and extended zone schemes. 10 L

UNIT 3
Dielectrics: Dielectric properties of insulators, Types of polarizations, Local fields , Claussius-Mosotti equation, Dielectric constant and loss, Introduction to piezo, Pyro, Ferroelectric materials.
Electrical Conductivity and Free Electron Fermi gas: Drude theory, DC conductivity, Hall effect and magneto-resistance, AC conductivity, thermal conductivity, Fermi-Dirac distribution, Free electron gas in three dimensions, thermal properties of an electron gas, Wiedemann-Franz law, critique of free-electron model. 10 L

UNIT 4
Magnetism: Types of magnetism, Susceptibility, Permeability and their relation. Diamagnetism: Langevin Quantum theory of Diamagnetism. Paramagnetism: Quantum Theory, Paramagnetism of rare earth and iron group ions, Paramagnetism of conduction electrons. Ferromagnetism, Ferrimagnetism and Antiferromagnetism: Curie point and exchange integral, saturation magnetization. Magnons: Magnon dispersion relation for ferromagnetic lattices, thermal excitation of Magnon and Bloch T3/2 law. Ferromagnetic Domains and their origin.Ferrimagnetic Ordering, Curie Temperature and susceptibility. Antiferromagnetic ordering, Neel temperature and Susceptibility, Antiferromagnetic magnon and magnon dispersion relation.

Superconductivity: Experimental evidence (Meissner effect, heat capacity, microwave properties, Isotope effect, energy gap), Destruction of superconductivity by magnetic field, Type I and type II superconductors, London equation, London penetration depth, Coherence length, BCS theory of superconductivity. 10 L

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Learning Outcome

1. Gain competence in understanding structures of solids obtained using XRD.
2. Understand the behaviour of electrons in solids including the concept of energy bands and effect of the same on material properties.
3. Understand the basis of electrical, thermal, magnetic and dielectric properties of solids.
4. Gain theoretical understanding of superconductivity
5. Use quantum mechanics/statistics to understand transport properties in solids.

Text book [TB]:

1. Dekker A.J., Solid State Physics, Prentice Hall (1965).
2. Kittel C., Introduction to Solid State Physics, John Willey (2004).
3. S.O. Pillai, Solid State Physics

Reference books [RB]:

1. Levy R. A. Principles of Solid State Physics, Academic Press (1968).
2. Mayers H. P., Introduction to Solid State Physics, Taylor & Francis (1997).
3. Srivastava J. P., Elements of Solid State Physics, Prentice-Hall of India Pvt. Ltd.(2004).
4. Ashcroft N.W. and Mermin N.D., Solid State Physics, Harcourt Asia Pvt. Ltd. (1976).

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Subject Code	PY 618	**Subject Title**	Electrodynamics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	II

Course Outline:
The course starts with an overview of electrostatic and magnetostatic boundary value problems, it covers the explained study of time varying fields and Maxwell equations, behavior of electromagnetic waves in different media.

Course Objective:
To apprise the students regarding the advanced concepts of electrodynamics and its use in various situations pertaining to static and dynamic conditions.

Course Pre/Co- requisite (if any) : Student must have studied electricity and magnetism at undergraduate level

Detailed Syllabus

UNIT 1
Boundary Value Problems: Uniqueness Theorem, Dirichlet or Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic &Magnetostatic Boundary value problem, Method of images with examples.
10 L

UNIT 2
Time Varying Fields and Maxwell Equations: Faraday's Law of induction, Displacement current, Maxwell equations, scalar and vector potentials, Gauge transformation, Lorentz and Coulomb gauges, Hertz potential, General Expression for the electromagnetic fields energy, Conservation of energy, Poynting's Theorem, Conservation of momentum. 10 L

UNIT 3
Electromagnetic Waves: Wave equation, Plane waves in free space and isotropic dielectrics, Polarization, Energy transmitted by a plane wave, Waves in conducting media, Skin depth. Reflection and Refraction of electromagnetic waves at plane interface, Fresnel's amplitude relations. Reflection and transmission coefficients, Polarization by reflection. Brewster's angle, Total internal reflection, EM wave guides, TE, TM and TEM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators.
10 L

UNIT 4
Dipole radiation: Retarded potential, electric and magnetic dipole radiation, radiation from an arbitrary distribution of charges and currents, radiation from a point charge. Lienard-Wiechert Potential, The fields of a point charge in motion, Power radiated by a point charge. 10 L

Learning Outcome
1. Solve complex problems of electrostatics
2. Gain competence in understanding the connection between time-varying fields and Maxwell equations.
3. Understand basic and complex aspects of electromagnetic waves including propagation.
4. To gain perspective on radiation from localized time varying sources, and the charged particle dynamics
5. Gain ideas relevant in pursuing research in areas of advanced experimental and theoretical physics.

Text book [TB]:

1. Jackson J.D., Classical Electrodynamics, Wiley Eastern (1999)
2. Puri S.P., Classical Electrodynamics, Tata McGraw Hill (1999).

Reference books [RB]:

1. Jordan E. C. and Balmain K. G., Electromagnetic Wave and radiating systems, Prentice Hall India Ltd. (1997).
2. Griffiths D.J., Introduction to Electrodynamics, Prentice Hall (1998).

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Subject Code	PY 619	**Subject Title**	Basic Electronics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	II

Course Outline:

The course starts with the overview of different types of transistors, then it covers IC fabrication techniques, photoelectric effect based devices, and negative resistance devices.

Course Objective:
To introduce concepts of circuit designs, characteristics of discrete components and provide an in-depth perspective of Digital Electronics to the students enrolled in the course.

Course Pre/Co- requisite (if any) : The student must have basic knowledge of semiconductors.

Detailed Syllabus

UNIT 1
Transistors Bipolar junction Transistor (BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Transistor ratings, The Ebers-Moll model, Field Effect Transistors: Junction Field Effect Transistor (JFET), Metal Oxide Semiconductor Field Effect Transistor (MOSFET) FET Parameters.
10 L

UNIT 2
Integrated circuits and Their Fabrications Types of Integrated Circuits, Analog and Digital Integrated Circuits, Semiconductor Fabrication: Planar Technology, Fabrication of Monolithic, Integrated Circuits, Monolithic Passive and Active Circuit components, Typical IC Low Frequency Amplifier, New Technology Trends. 10 L

UNIT 3
Photoelectirc and other Electronic Devices Zener Diode, Power Diode, Photodiode, Varactor Diode, Light Emitting Diode (LED), Solar Cell, Transistor Register, Piezo-electric Crystals, Diode Lasers, Condition for Laser Action, Optical Gain, Memory Devices:Transistor Register, Random Access Memory, Read Only Memory. 10 L

UNIT 4
Negative Resistance Devices Tunnel Diode, Backward Diode, Unijunction Transistor, p-n-p-n devices, p-n-p-n characteristics Thyristor, Silicon Controlled switch, SCS Characteristics, L Addition four Layer Devices. Basic Circuit Principles for NR Switching Circuits: Monostable, Bi-stable and Astable Operations. 10 L

Learning Outcome

1. Understand the characteristics of basic and advanced components for analogue circuit design
2. Gain exposure to Technologies used for fabrication of Integrated Circuits
3. Gain knowledge in using components to build basic and advanced logic circuits
4. Gain perspective of advanced semiconductor devices active and passive components used in control systems
5. Understand the usage of truth table to interpret logical circuits.

Text book [TB]:

1. Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)
2. Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)
3. Pulse, Digital and Switching Waveforms by Jacob Millman and Herbert Taub , Mc Graw Hill Book Company (1965).

Reference books [RB]:

1. Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)
2. Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons
3. Measurement, Instrumentation and Experimental Design in Physics and Engineering by M.Sayer and A. Mansingh, Prentice Hall, India (2000)
4. Optical electronics by AjoyGhatak and K. Thygarajan, Cambridge Univ. Press.

Subject Code	PY 626	**Subject Title**	Atomic and Molecular Physics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	1st	**Semester**	II

Course Outline:

The course prepares the student for further studies in applied atomic and molecular spectroscopy, basic material physics and research in atomic and molecular physics.

Course Objective:

The objective of the course is to have the students learn the theory applicable for various spectroscopy techniques that enables understanding of molecular structure and associated energy levels.

Course Pre/Co- requisite (if any) : The student must have studied elements of modern physics

Detailed Syllabus

UNIT 1

Atomic Spectroscopy: Hydrogen, Helium and Alkali spectra, Vector atom model of Hydrogen atom, Relativistic correction, Spin-orbit coupling, Hydrogen fine structure, Spectroscopic terms, LS coupling, Pauli exclusion principle, Interaction energy for LS coupling, Lande interval rule, jj coupling, interaction energy for jj coupling, Hyperfine structure. 14 L

UNIT 2

Atom in Magnetic and Electric Field: Zeeman effect, Magnetic moment of a bound electron, Magnetic interaction energy in weak field. Paschen-Back effect, Magnetic interaction energy in strong field, Stark effect, First order Stark effect in hydrogen. Quantum mechanical treatment of both the effects. 10 hr

UNIT 3

Molecular Spectroscopy: Rotational and vibrational spectra of diatomic molecule, Raman Spectra, Born-Oppenheimer approximation, Vibrational coarse structure, Franck-Condon principle, Rotational fine structure of electronic-vibration transitions, Electronic spectra. 12 L

UNIT 4

Spin Resonance Spectroscopy: Electron spin resonance and nuclear magnetic resonance spectroscopy.
4 L

Learning Outcome

1. Gain understanding of the application of quantum mechanics to explain one and many electron atoms.
2. To gain insight related to fine structure of the spectral lines and the splitting of spectral lines in the presence of perturbing agents such as electric and magnetic fields
3. To be able to understand the physics behind the various kinds of spectrum of simple molecules.
4. To understand the principle and application of resonance spectroscopy.
5. Also learn the sources of aberration of experimental spectra with respect to the proposed models used for solving the Schrodinger's equation and incorporate the necessary corrections.

Text book [TB]:

1. Banwell C. N. and McCash E. M., Fundamentals of molecular spectroscopy , Tata McGraw Hill (1994).
2. B.H. Bransden& C. J. Joachin Physics of Atoms and Molecules.2nd Edition Prentice Hall (2003)

Reference books [RB]:

1. White H. E., Introduction to Atomic Spectra, McGraw Hill (1934).

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 627	Subject Title	Nuclear and Particle Physics						
LTP	4 0 0	Credit	4	Subject Category	CC	Year	1st	Semester	II

Course Outline:

The course starts with basic concepts of a nucleus and covers the phenomenology and experimental foundations of particle and nuclear physics including the fundamental forces and particles and composites.

Course Objective:
To impart theoretical background of nuclear physics and nuclear models to understand the related reaction dynamics.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1
Two nucleon problem and nuclear forces: The deuteron : binding energy, dipole moment quadrupole moment and the evidence of non-central (Tensor) force, spin dependence of nuclear force. Nucleon-nucleon scattering; s-wave effective range theory, charge independence and charge symmetry of nuclear forces, iso-spin formalism. 10 L

UNIT 2
Nuclear Models : Liquid drop model ,stability of nuclei, fission ; evidence of shell structure, the shell model, spin parity and magnetic moment in extreme single particle model, evidence of collective excitations, collective vibration of a spherical liquid drop. 10 L

UNIT 3
Nuclear decays and nuclear reactions : Alpha, Beta and Gamma decays, Selections rules, Fermi's theory of beta decay, selection rules, comparative half lines, Kurie plot Fermi and Gamow -Teller Transitions; parity non-conservation in beta decay. Reaction cross section, compound nuclear reactions and direct reactions, the optical model, Breit-Winger resonance formula for l=0. 10 L

UNIT 4
Elementary Particle: Basic interactions in nature: Gravitational Electromagnetic, weak and strong, classification of elementary particles, Leptons, Hadrons, Mesons, Baryons. Conservation Laws for Elementary Particles.Baryon, Lepton and Muon number, Strangeness and Hypercharge, Gelleman - Nishijima formula. Quark model, SU (2) and SU (3) Symmetries Parities of subatomic particles, charge conjugation, Time reversal. 10 L

Learning Outcome

1. Gain competence in understanding the bound state of nucleus and properties of the proposed models
2. Understand the relevance of the various nuclear reaction mechanisms
3. Classification of the elementary particles based on their fundamental properties.
4. Decay mechanism of the various nuclei
5. Applicability of symmetry and parity in cases of subatomic particles.

Text book [TB]:

1. Kaplan Irving Nuclear Physics, Narosa Publishing House (2000).
2. Tayal D. C., Nuclear Physics, Himalaya Publication home (2007)
3. Ghoshal S.N., Nuclear Physics, S.Chand, Jan (1994)

Reference books [RB]:

1. Roy R.R. & Nigam B.P., Nuclear Physics, New Age International Ltd (2001).
2. Preston M. A. and Bhaduri R. K., Structure of Nucleus Addision-Welsey (2000).
3. Pal, M.K., Theory of Nuclear Structure, East-West Press Delhi (1983).

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 628	**Subject Title**	Physics lab II						
LTP	0 0 6	**Credit**	3	**Subject Category**	CC	**Year**	1st	**Semester**	II

Course Outline:

The laboratory course covers the experiments based on optical fibre, semiconductors, transistors, amplifiers.

Course Objective:
To teach the students properties of semiconductor by having the students perform hands on experiments supervised by a specialized instructor.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

1. To measure the numerical aperture (NA) of optical fiber.
2. The Hall coefficient for given semiconductor and study its field dependence
3. To study the dielectric behavior of PZT ceramic by determining dielectric strength, dielectric constant and dielectric glasses.
4. To study the ESR spectrum
5. To study the NMR spectrum
6. Gain characteristics of a double stage RC coupled BJT amplifier.
7. Drain, transfer characteristics of a JFET.
8. Static characteristics and 90^0 phase control of a Silicon Controlled Rectifier (SCR).
9. Electrical properties of thin film deposited through spin coating technique.
10. To study MOSFET as output power amplifier.

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

1. Gain competence in the basics of fibre optics
2. Gain exposure in measurement of various properties of semiconductors
3. Gain understanding of properties of BJT and FET
4. Gain experience in materials research lab for future research work
5. Gain exposure in advanced design and analysis of data obtained from electronic circuits.

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 706	**Subject Title**	Physics of Semiconductor Devices						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	2nd	**Semester**	III

Course Outline:

The course covers detailed study of semiconductors, carrier transport in semiconductors, transistors, and memory devices.

Course Objective:
To develop amongst the students the knowledge of semiconductor physics and the applications of basic devices, including p-n junctions, BJTs and FETs.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1
Semiconductor Materials: Energy Bands, Intrinsic carrier concentration. Donors and Acceptors, Direct and Indirect band semiconductors. Degenrate and compensated semiconductors. Elemental (Si) and compound semiconductors (GaAs). Replacement of group III element and Group V elements to get tertiary alloys such as $Al_xGa_{(1-x)}As$ or $GaP_yAs_{(1-y)}$ and quaternary $InxGa_{(1-x)}P_yAs_{(1-y)}$) alloys and their important properties such as band gap and refractive index changes with x and y. Doping of Si (Group III (n) and Group V (p) compounds and GaAs (Group II (P), IV (n.p.) and VI (n compounds). Diffusion of Impurities - Thermal Diffusion, Constant Surface Concentration, Constant Total Dopant Diffusion, Ion Implantation. 8 L

UNIT 2
Carrier Transport in Semiconductors: Carrier Drift under low and high fields in (Si and GaAs), saturation of drift velocity, High field effects in two valley semiconductors. Carrier Diffusion, Carrier injection, Generation Recombination Processes - Direct, Indirect bandgap semiconductors, Minority Carrier Life Time, Drift and Diffusion of Minority Carriers (Haynes-Shockley Experiment) Determination of; Conductivity (a) four probe and (b) Van der Paw techniques. Hall coefficient, Minority Carrier Life Time. Junction Devices: (i) p-n junction, effect of indirect and surface recombination currents on the forward biased diffusion current, p-n junction diodes - rectifiers (high frequency limit), (ii) Metal - semiconductor (Schottky Junction) : Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states. Applications of Schottky diodes, (iii) Metal Oxide - Semiconductor (MOS) diodes.Energy band diagram, depletion and inversion layer.High and low frequency Capacitance Voltage (C-V) characteristics.Smearing of C-V curve, flat band shift.Application of MOS diode. 10 L

UNIT 3
Transistors: JFET, BJT, MOSFET and MESFET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions. High Frequency Limits.Microwave Devices Tunnel diode, transfer electron devices (Gunn diode). Avalanche Transit time devices (Read, Impatt diodes, and parametric devices) Photonic Devices Radiative and non-radiative transitions. Optical Absorption. Bulk and Thin film Photo - conductive devices (LDR) diode photodetectors, Solar cell - (Open circuit voltage and short circuit current, fill factor), LED (high frequency limit, effect of surface and indirect recombination current, operation of LED), diode lasers (conditions for population inversion, in active region, light confinement factor. Optical gain and thershold current for lasing, Fabry - Perrot Cavity Length for lasing and the separation between modes). 10 L

UNIT 4
Memory Devices: Static and dydnamic random access memories SRAM and DRAM CMOS and NMOS, nonvolatile - NMOS, magnetic optical and ferroelectric memories, charge coupled devices (CCD).
Other Electric Devices: Electro-Optic, Magneto-Optic and Acousto-Optic Effects. Material Properties related to get these effects. Important Ferroelectric Liquid Crystals and Polymeric materials for these devices. Piezoelectric, Electrostrictive and magneto strictive Effects, Important materials exhibiting these properties, and their

applications in sensors and actuator devices. Acoustic Delay lines, piezoelectric resonators and filters. High frequency piezoelectric devices- Surface Acoustic Wave Devices.Pyroelectric effect.Inorganic oxide and Polymer pyroelectric materials and their applications. 12 L

Learning Outcome

At the end of the course, the student will have the understanding of

1. basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.
2. properties of the semiconductors to understand the working and applications of various semiconducting devices including photo conductors, p-n junctions, BJTs and FETs.
3. Necessity, applications and the physics of bulk electronic devices
4. Properties of semiconductors allowing their use in novel areas
5. Usage of semiconductors as memory devices

Text book [TB]:

1. Thin film phenomena by K.L.Chopra
2. The material science of thin films, Milton S. Ohring Optical electronics by AjoyGhatak and K. Thyagarajan. Cambridge Univ.

Reference books [RB]:

1. The Physics of semiconductor Devices by D.A. Eraser, Oxford Physics Series (1986) Semiconductor Devices - Physics and Technology, by SM Sze Wiley (1985)
2. Introduction to semiconductor devices, M.S .Tyagi, John Wiley & Sons
3. Measurement, Instrumentation and Experimental Design in Physics and Engineering by M. Sayer and A. Mansingh, Prentice Hall, India (2000)

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 707	**Subject Title**	Analog Electronics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	**2nd**	**Semester**	III

Course Outline:

The course covers photoelectric effect detectors, fundamentals of modulation, amplifiers, AC/DC coverters, Schmitt trigger, pulse generators.

Course Objective:
To develop amongst the students the theoretical and application concepts of basic analogue electronics

Course Pre/Co- requisite (if any) : The student must have studied analog system and applications

Detailed Syllabus

UNIT 1
External Photoelectric Effect detector: Vacuum photodiode, photo-multipliers, microchannels, Internal Photoelectric Effect detectors: pn junction photodiode, solar cell (open circuit voltage, short circuit current, fill factor), pin photodiode, avalanche photodiode, phototransistor, Light emitting diode. 10 L

UNIT 2
Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation: PAM, PTM, PWM, PPM, PCM (in brief) 10 L

UNIT 3
Differential amplifier, CMRR, circuit configuration, emitter coupled supplied with constant current, transfer characteristics, block diagram of Op. Amp. Off-set currents and voltages, PSRR, Slew rate, universal balancing techniques, Inverting and non-inverting amplifier, basic applications- summing, scaling, current to voltage and voltage to current signal conversion, differential dc amplifier, voltage follower, bridge amplifier, AC-coupled amplifier. 10 L

UNIT 4
Integration, differentiation, analog computation, Butterworth active filter circuits, logarithmic amplifier, antilogarithmic amplifier, sample and hold circuits, digital to analog conversion – ladder and weighted resistor types, analog to digital conversion- counter type, AC/DC converters, comparators, regenerative comparator (Schemitt trigger), Square wave generator, pulse generator, triangle wave generator.

10 L

Learning Outcome
At the end of the course the students will be able to:
1: Gain understanding of the working principle of components for converting optical signals to electronic signals.
2: Be competent in concepts of various types of modulation for signal transmission
3: Gain insight in characteristics and applicability of various kinds of amplifier circuits.
4: Gain competence in the understanding of the circuitry of elementary and advanced filters
5: Learn the use of op-amps for developing convertor, comparator, differentiator circuits

Text book [TB]:

1. Solid State Electronic Devices by Ben G. Streetman ((Parentice Hall of India)
2. Semiconductor Optoelectronic devices by Pallab Bhattacharya (Parentice Hall of India)

Reference books [RB]:

1. Integrated Electronics by J. Millman and C.C.Halkias (Tata-McGraw Hill)
2. Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
3. Electronics communication Systems by George Kennedy and Bernard George (McGraw Hill). Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 709	**Subject Title**	Measurement Techniques in Physics						
LTP	4 0 0	**Credit**	4	**Subject Category**	CC	**Year**	**2nd**	**Semester**	III

Course Outline:

The course covers basics of measurement, sensors and transducers, Dc and AC measurements, signal conditioning and noise.

Course Objective:

To have the students gain insight in measurement techniques which would enable them understand instrumentation.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1

Data Interpretation and Analysis: Precision and accuracy, Errors in measurements: Statistical and systematic, Error analysis, Propagation of errors. Frequency distributions, Probability distributions: mean and variance, Probability densities: Normal distribution, Log-Normal distributions. 10 L

UNIT 2

Transducers: Sensors and Transducers: Temperature, Pressure, Vibration, Magnetic Field, Force and Torque, Optical. 10 L

UNIT 3

Measurements: Resistance: DC Measurements: Wheatstone Bridge, The Kelvin Bridge, Potentiometers, AC Measurements: Inductor and capacitor equivalent circuits, AC operation of a Wheatstone bridge, Capacitance Measurement: The resistance ratio bridge, The De Sauty Bridge, Wein Bridge. Inductance Measurement: The Maxwell Bridge, Parallel Inductance bridge, Anderson bridge. Voltage Measurement: AC and DC, Current Measurement: AC and DC. Resistivity Measurement: 2-probe, 4-probe and Van-der-Paw measurements 10 L

UNIT 4

Signal Conditioning and Noise: Signal Conditioning, Analog signal conditioning: Operational amplifiers, Instrumentational amplifiers, precision absolute value circuits, True RMS to DC converters. Phase sensitive detection: Lock in amplifier, Box-car integrator, Spectrum analyzer. Noise in Circuits: Probability Density Functions, The Power Density Spectrum, Sources of noise, Noise limited resolution of Op-amp, minimum resolvable DC current, Coherent interference and its sources, Ground loops and their prevention. Introduction to Digital signal conditioning. The Fast Fourier Transformer, Sampling time and Aliasing, Voltage and Current sources. 10 L

Learning Outcome

The students will be able to gain competence in:

1. Statistical interpretation of data
2. Sensors and Transducers to be used for measuring signals for interpreting physical quantities
3. Various measurement techniques related to electrical components and signal
4. Analysis of signals and noise
5. Analogue circuits for use in signals and control systems.

Text book [TB]:

1. Johnson Richard A., Probability and Statistics for Engineers, Pearson Education Asia (2000).
2. Horowitz P. and Hill W., The Art of Electronics, Cambridge University Press(2002).
3. Helfrick, A.D., Cooper, W.D., Modern Electronic Instrumentation and Measurement Techniques, PHI(2003).

Reference books [RB]:

1. Sayer, M., Mansingh, A., Measurement, Instrumentation and Experiment Design in Physics and Engineering, PHI (2000)
2. Northop Robert B., Introduction to Instrumentation and Measurements, CRC, Taylor and Frances (2005).
3. Murthy D.V.S., Transducers and instrumentation, PHI (1995).

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 746	**Subject Title**	Physics of Lasers and Applications						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2**	**Semester**	III

Course Outline:

The course covers the study of LASER characteristics, pumping processes, different types of lasers and photoelectric effect.

Course Objective:
The course aims at imparting knowledge about Lasers and their applications

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1
Laser characteristics: Spontaneous and Stimulated Emission, Absorption, Laser Idea, Pumping Schemes, Properties of Laser Beams: Monochromativity, Coherence, Directionality, Brightness, Radiation Trapping Superradiance, Superfluorescence, Amplified Spontaneous Emission, Non-radiative delay.
10 L

UNIT 2
Pumping process: Optical pumping and pumping efficiency, Electrical pumping and pumping efficiency. Passive Optical Resonators, Rate Equations, Four-level Laser, Three-level Laser, Methods of Q-switching : Electro optical shutter, mechanical shutter, Acousto - optic Q-switches, Mode locking.
10 L

UNIT 3
Ruby Laser, Nd-Yag Laser, N2 Laser, Dye-Laser, Semiconductor Laser. 10 L

UNIT 4
Multiphoton photo-electric effects, Two-photon, Three-photon and Multiphoton Processes Raman Scattering,Stimulated Raman Effect.Introduction to Applications of Lasers : Physics, Chemistry, Biology, Medicine, Material working ,optical communication, Thermonuclear Fusion, Holography, Military etc. 10 L

Learning Outcome
On completion of the course the student willgain understanding of
1. Different types of emission and basic requirements of laser systems
2. Techniques for effective laser emission
3. Various types of lasers gaseous, dye and solid-state lasers
4. Advanced photoelectric effects
5. Application of laser in modern technology systems

Text book [TB]:
1. Letekhov : Non-Linear Spectroscopy
2. Principles of Lasers by Svelto
3. Lasers and Non-linear Optics by B.B. Laud

Reference books [RB]:
1. Introduction to Atomic and Molecular Spectroscopy by V.K.Jain
2. Svelto : Lasers
3. Yariv Optical Electronics
4. Demtroder: Laser Spectroscopy

Subject Code	PY 747	**Subject Title**	Science and Technology of Renewable Energy Sources						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2nd**	**Semester**	III

Course Outline:

The course gives the students an idea of natural energy resources and how they can be utilized for energy demand in near future

Course Objective:

The course aims at imparting knowledge about renewable energy.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1

Solar Cells 1. Elements of solar cells operation, semiconductors, light absorption and carrier generation, carrier recombination, pn junction, short circuit current, efficiency, factors affecting the conversion efficiency, Bandgap Energy, Temperature, Recombination Life Time, Light Intensity, Doping Density, Surface Recombination Velocities, Series Resistance. 10 L

UNIT 2

Solar Cells 2. Thin film and other unconventional cell materials, Copper Indium Selenide/CadiumSulphide solar Cells, Indium Phosphide Solar Cells, Tin Oxide and Indium Tin Oxide, Polymer-semiconductor Schottky Barrier Cells, Organic Solar Cells, Loss Mechanisms, Multiple Cell system : spectrum splitting and cascade cells, thermocouple voltaic system, photo electrolytic cell, satellite power system. 10 L

UNIT 3

Hydrogen Energy, Production and Utilizaztion Relevance in relation to depletion of fossile fuels and environmental considerations, solar Hydrogen Energy system, Solar Hydrogen production, direct thermal, thermochemical, electrolytic, photolytic, use of Hydrogen as a fuel, Use in vehicular transport, hydrogen for electricity generation, Fuel cells and other uses. 10 L

UNIT 4

Other Renewable Clean Energies Elements of Solar thermal energy, Wind energy and Ocean thermal energy conversion. 10 L

Learning Outcome

On completion of the course the student willgain understanding of

1. The knowledge of various sources of energy
2. Use of Hydrogen fuels
3. Various types of solar cells used, efficiency and mechanism of fuels
4. Light absorption by semiconductors
5. Using non-solar but novel methods of exploiting natural sources of energy such as wind and ocean.

Text book [TB]:

1. Hydrogen as an Energy Carrier -Technologies, Systems Economy by Winter and Nitch (Eds)
2. Fundamentals of Solar Cells Photovoltaic Solar Energy by Fahrenbruch and Bube

Reference books [RB]:

1. Solar Cells by ChenmingkHu and R.M. White (McGraw Hill 1983)
2. Solar Energy Engineering ed by A.A.A. Sayigh (Academic Press)

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 748	**Subject Title**	Microprocessor and Application						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2nd**	**Semester**	III

Course Outline:
The course covers basics of microprocessor and its architecture, programming of microprocessor, memory interface and interrupts.

Course Objective:
The course aims at imparting knowledge about microprocessor and applications

Course Pre/Co- requisite (if any) :no essential pre-requisite

Detailed Syllabus

UNIT 1
Microprocessors and Architecture: Internal Microprocessor Architecture, Real mode and protected modes of memory addressing, memory paging. Addressing modes: Data addressing modes.Program memory addressing modes, Stack memory addressing modes. Instruction Set: Data movement instructions, Arithmetic and Logic instructions, Program control instructions. Assembler details. 10 L

UNIT 2
Programming the Microprocessor: Modular programming, using the keyboard and video display, Data conversions, Disk files, Example programms. Hardware Specifications : Pin outs and the Pin functions, clock generator (8284A), Bus buffering and Latching, Bus timing. Ready and wait state, Minimum mode versus maximum mode. 10 L

UNIT 3
Memory interface, Memory devices, Addresses decoding, 8088 and 80188 (8-bit) memory interface, 8086, 80186, 80286 and 80386 (16-bit) memory interface, 80386 DX and 80486 (32- bit) memory interface, Dynamic RAM. Basic I/O Interface : Introduction to I/O interface, I/O port address decoding 8255, 8279, 8254, 16550, ADC and DAC (excluding multiplexed display & keyboard display using 8255) 10 L

UNIT 4
Interrupts : Basic interrupt processing, Hardware interrupts. Expanding the interrupt structure, 8259A PIC. Direct Memory Access : Basic DMA operation, 8237 DMA controller, Shared Bus operation, Disk memory systems, Video displays 10 L

Learning Outcome
On completion of the course the student willgain understanding of

1. Microprocessor and peripheral devices
2. Operating and Designing of microprocessors
3. Interfacing microprocessors with circuits
4. Programming with microprocessors directly
5. Various types of microprocessors.

Text book [TB]:

1. Douglas V. Hall, "Microprocessors and Interfacing, Programming and Hardware", second edition, McGraw Hill International Edition, 1992.
2. Muhammad Ali Maxidi and Janice GillispieMazidi, "The 80x86 IBM and Compatible Computers (Volumes I & II). Second edition, Prentice - Hall, International

Reference books [RB]:

1. Barry B.Brey, "The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486,
2. Pentium and Pentium Pro processor architecture, programming and interfacing "Fourth Edition, PHI, 1999.

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 716	**Subject Title**	Physics Lab III						
LTP	0 0 6	**Credit**	3	**Subject Category**	CC	**Year**	**2nd**	**Semester**	III

Course Outline:

The laboratory course covers the experiments based on digital electronics and nuclear physics also.

Course Objective:
To get hands on experience in electronics

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

1. To study time resolution of a gamma-ray coincidence set-up. Energy resolution and calibration of a gamma-ray spectrometer using multi-channel analyzer.
2. Time resolution and calibration of a coincidence set-up using a multi- channel analyzer.
3. Calibration of a beta-ray spectrometer. $\pi-\mu$events in nuclear emulsion. Absorption coefficient of Al, Fe and Pb for gamma-rays using scintillation counter.
4. To study the switching characteristics of a transistor (NPN & PNP).
5. Digital I: Basic logic gates, TTL, NAND and NOR.
6. Digital II: Combinational Logic.
7. Flip Flops.
8. Operational amplifier (741)
9. Study of frequency modulation and demodulation
10. Study of pulse amplitude modulation & demodulation model-C019
11. Feedback amplifier
12. To study the frequency response of wo stage
    a. Transformer coupled amplifier

    b. Choke coupled amplifier

Learning Outcome

On completion of the course the student will be acquiring foundation in

1. Handling instrumentation techniques associated with nuclear physics
2. Get hands on experience with advanced logical circuits
3. the calibration techniques for nuclear experiments
4. modulation and demodulation techniques
5. basic and advanced amplifier circuits.

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	MA748	**Subject Title**	Computational Techniques and Programming						
LTP	302	**Credit**	4	**Subject Category**	GEC	**Year**	2^{nd}	**Semester**	IV

Objective: To have the students gain exposure in various computational techniques to solve physics problems using advance computer programming languages.

Unit I Numerical Methods Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions. Solutions of simultaneous linear equations, Gaussian elimination, pivoting, iterative Method, matrix inversion.

Unit II Eigenvalues and eigenvectors of matrices, Power and Jacobi Method Finite differences, interpolation with equally spaced and unevenly spaced points. Curve fitting, Polynomial least squares and cubic Spline fitting.Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method.

Unit III Monte Carlo methods and numerical solution of differential equations Random variate, Monte Carlo evaluation of integrals, Methods of importance sampling, Random walk and Metropolis method. Numerical solutions of ordinary differential equations, Euler and Runge -Kutta methods, Predictor and corrector methods, Elementary ideas of solutions of partial differential equations.

Unit IV FOSS TOOL: PYTHON Installation of the software for Python, Basic syntax, Mathematical Operators, Predefined constants, Built in functions. Complex numbers, polynomials, Vectors, Matrix. Handling these data structures using built in functions. Programming, Functions, Loops, Conditional statements. Handling .py files, Graphics handling -2D, 3D, Function plotting, Data plotting.

Course Outcome: The students will be able to gain competence in:

1. Numerical techniques
2. Complex curve fitting and execute problems in calculus using computer.
3. using numerical techniques to solve basic and advanced differential equations
4. Developing programs in Python for solving programs.

Recommended Books:

1. Gerald, C.F., and Wheatley P.O., Applied Numerical Analysis, Addison Wesley (2003).

2. Atkinson, K. E. and W. Han, Elementary Numerical Analysis, John Wiley & sons (2004).

3. Jain, M.K., Iyengar, S.R.K., and Jain, R.K., Numerical Methods for Scientific and EngineeringComputation, New Age International Publisher (2012).

4. *Burden R. L. and Faires J. D., Numerical Analysis, Brooks Cole, 2004*

5. Paul Barry, Head First Python, O'Reilly Media, Inc., 2nd Edition (2016).

***6.** Zed A Shaw, Learn Python the Hard Way, Zed* Shaw's Hard Way Series, 3rd *Edition (2013).*

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 756	**Subject Title**	Digital Electronics						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2nd**	**Semester**	4

Course Outline:
This course provides an in depth study of the principles and applications of digital systems . The course covers the basic building blocks of digital systems and the process of building a digital design project and testing it. The laboratory exercises are designed to complement the theory of digital circuits

Course Objective:
To provide theoretical knowledge and develop practical skills in digital systems and logic systems.

Course Pre/Co- requisite (if any) : no essential pre-requisite

Detailed Syllabus

UNIT 1
NUMBER SYSTEMS Binary numbers, Octal numbers, Hexadecimal numbers, Inter-conversions of numbers. Binary addition, subtraction, multiplication, signed numbers, 1's complement, 2's complement, 2's complement subtraction, Hexadecimal addition, subtraction, BCD code, Gray code, conversion from binary to Gray code and Gray code to binary code. 10 L

UNIT 2
DIGITAL ELECTRONICS Positive and negative logic designations, OR gate, AND gate, NOT gate, NAND gate, NOR gate, XOR gate, Circuits and Boolean identities associated with gates, Boolean algebra DeMorgans Laws, Sum of products and product of sums expressions, Minterm, Maxterm, deriving SOP and POS expressions from truth tables. 10 L

UNIT 3
COMBINATIONAL AND SEQUENTIAL LOGIC Binary adders, half adders, full adders, decoders, multiplexer, demultiplexer, encoders, ROM and applications, Digital comparator, Parity checker and generator, Flip-Flops- RS, JK, master slave JK, T-type and D-type flip flops, Shift-register and applications, Asynchronous counters and applications. 10 L

UNIT 4
MOS TECHNOLOGY AND DIGITAL CIRCUITS Metal oxide semiconductor field effect transistors, enhancement mode transistor, depletion mode transistor, p-channel and n-channel devices, MOS invertors- static inverter, dynamic inverter, two phase inverter, MOS NAND gates, NOR gates, complementary MOSFET technology, CMOS inverter, CMOS NOR gates and NAND gates, MOS shift register and RAM 10 L

Learning Outcome
On completion of the course the student will be acquiring foundation in
1. logical circuits, systems and microprocessor.
2. designing operating systems
3. solving problems in digital electronics including various number systems
4. fundamentals of MOSFET circuitry
5. combinational and sequential logic

Text book [TB]:
1. Digital logic by J. M.Yarbrough (Thomson Publication)

Reference books [RB]:
1. Integrated Electronics by J. Millman and C.C. Halkias (Tata McGraw Hill)
2. Digital Electronics by William Gothmann (Parentice Hall of India)

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 757	Subject Title	Nano Electronics						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2**	**Semester**	IV

Course Outline:

The course covers physics of materials at low dimension, quantum confinement, synthesis and characterization of nanomaterials, nanocomposites, nano and biophotonics, and nanomedicine.

Course Objective:

To provide theoretical knowledge of different concepts of nano scale and electronics properties of materials

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1

Physics of low dimensions: Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, insulators and semiconductors, Density of states in bands, Variation of density of states with energy, Variation of density of states and band gap with size of crystal. Electron confinement in infinitely deep square well, confinement in two and one dimensional well, Idea of quantum well structure, Quantum dots, Quantum wires. 10 L

UNIT 2

Growth and characterization of Nanomaterials: Growth Methods for Nanomaterials, Epitaxial Growth, Laser-Assisted Vapor Deposition (LAVD) nanochemistry, characterization of Nanomaterials, X-ray Characterization, Determination of particle size, Increase in width of XRD peaks of nanoparticles, Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM). Shift in photoluminescence peaks, Variations in Raman spectra of nanomaterials. 10 L

UNIT 3

Nanocomposites and industrial nanophotonics: Nano composites as photonic media, nanocomposites waveguides, Random lasers: Laser paints, Local field Enhancement, Multiphasic nanocomposites, nanocomposites for optoelectronics. Nanolithography, nanoparticle coatings, Sunscreen nanoparticles, Self-cleaning Glass Fluorescent Quantum Dots, Nanobarcodes. 10 L

UNIT 4

Bio Nanophotonics and nanomedicine: Bioderived materials, bioinspired materials, biotemplates, bacteria as biosynthesizers, Near-field Bioimaging, nanoparticles for optical diagnostics and Targeted therapy, semiconductor quantum dots for bioimaging.Biosensing, Nanoclinics for optical diagnostics and targeted therapy, Nanoclinic Gene Delivery nanoclinics for Photodynamic therapy. 10 L

Learning Outcome

On completion of the course the student will have

1. basic knowledge of nano-scale electronics
2. knowledge of application of nano-materials in areas of electronics, sensing and medicines
3. fundamental ideas of characterization of nano-material
4. idea of the physics to be applied to nano-level material
5. idea of fabrication of nano composites.

Text book [TB]:

1. Physics of Semiconductors nano structures by K.P. Jain, Narosa 1997

Reference books [RB]:

1. Nanophotonics-PN Prasad, Wiley Interscience (2003)
2. Biophotonics-PN Prasad, Wiley Publications (2004)

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	PY 758	**Subject Title**	Optoelectronics						
LTP	4 0 0	**Credit**	4	**Subject Category**	DSE	**Year**	**2nd**	**Semester**	IV

Course Outline:

The course covers the basic knowledge of semiconductors and explains the physics behind optoelectronic devices, modulation of light and display devices.

Course Objective:
To provide insight and develop in the students the background required for understanding discrete components necessary for fibre optic communication.

Course Pre/Co- requisite (if any) : no pre-requisite

Detailed Syllabus

UNIT 1
Nature of light, light sources, black body, colour temperature, units of light, radio metric and photometric units, basis semiconductors, effect of pressure and temperature on band gap, PN junction, carrier recombination and diffusion, injection efficiency, heterojunction, internal quantum efficiency, external quantum efficiency, double hetero junction, fabrication of heterojunction, quantum wells and super lattices. 10 L

UNIT 2
Opto electronics devices, optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits, LED and laser drive circuits, LED-Power and efficiency, double heterostructure LED, LED structures, LED characteristics, Laser modes, strip geometry, gain guided lasers, index guided lasers. 10 L

UNIT 3
Modulation of light, birefringence, electrooptic effect, EO materials, Kerr modulators, scanning and switching, self electro optic devices, MO devices, AO devices, AO modulators. 10 L

UNIT 4
Display devices, Photoluminescence, cathode luminescence, EL display, LED display, Drive circuitary, plasma panel display, liquid crystals, properties, LCD display, numeric displays.
Photo detectors, thermal detectors, photoconductors, detectors, photon devices, PMT, photodiodes, photo transistors, noise characteristics of photo-detectors, PIN diode, APD characteristics, APD design of detector arrays, Solar cells-I-V characteristics and spectral response. Materials and design considerations of solar cells.
10 L

Learning Outcome
On completion of the course the student will

1. Gain competence in photometry such as display and CIE certified chromaticity diagrams
2. Able to have gained foundation of selecting appropriate LED based light sources
3. Have clear background of electro-optic effects
4. Gain understanding of working principles of LCD panels
5. Have gained insight about modern day applications of optics in instrumentation.

Text book [TB]:

1. Semiconductor optoelectronic devices- P Bhattacharya (Prentice Hall of India, 1995).
2. Fibre Optics and Opto-electronics, RP Khare (Oxford University Press, 2004).

Reference books [RB]:

1. Opto electronics- An introduction- J Wilson and JFB J iS Hawkers.
2. Optical fibre communication- JM Senior (Prentice Hall India 1985).
3. Optical fibre communication systems- J Gowar (Prentice Hall India 1995).

Department of Physics
Course Structure of M.Sc. Physics
Applicable for 2018-20 Batch

Subject Code	MB604	Subject Title	Organizational Behavior						
LTP	300	Credit	3	Subject Category	AEC	Year	2nd	Semester	IV

Course Objective:

To enhance understanding of the dynamics of interaction between individual and the organization; Facilitate a clear perspective to diagnose and effectively handle human behavior issues in organization; Develop greater insight into their own behavior in interpersonal and group team situations; Acquire skills in influencing people in organizations; To help students to become aware of the influence of organizational structures and designs on the attitudes and performance of people working in organizations

Course Pre/Co- requisite (if any) :

UNIT 1: Introduction to OB
Organizational Behavior- Introduction; Models of OB; Workforce Diversity, Determinants of Individual Behavior.
UNIT 2: Foundations of Individual Behavior
Transactional Analysis; Johari Window; Personality; Conflict management
UNIT 3: Culture and Climate
Organizational Culture & Climate, Organizational Learning & reinforcement
UNIT 4: Change Management
Organizational change: nature, planned change, resistance and its management, Organizational development: concept, processes and techniques
UNIT 5: Group Dynamics
Group cohesiveness, Types of Group and Group formation, Leadership effectiveness. Power and politics

Learning Outcome

After the end of this course, student shall be able to

i. To help the students to develop cognizance of the importance of human behaviour.
ii. To enable students to describe how people behave under different conditions and understand why people behave as they do
iii. To provide the students to analyse specific strategic human resources demands for future action.

Text book [TB]:

i. Organizational Behaviour, 7th ed. ,by Luthans, Fred McGraw-Hill, New York

Reference books [RB]:

ii. Johns, G., and Saks, Organizational Behaviour- Understanding and Managing life at work, 7th Ed., Pearson.
iii. Gerard H. Seijts, Cases in Organization Behavior, 1st Edition, Sage.
iv. Jerald Greenberg, Behavior in Organizations, 10th Edition, Prentice Hall.
v. Organizational behaviour,9th edition by Stephen P.Robbins. Prentice Hall International, Inc..
vi. Luthans, Fred, OrganizationalBehaviour: An evidence based approach, 12th edition. Tata McGraw Hill
vii. UdayPareek, Understanding Organizational Behavior, 3rd Edition, Oxford University Press,