Evaluation/Scheme of Examination
M.Sc. (Physics)
With Effect From session: 2020-21

1st Semester

S. No.	Course Code	Course Title	Type of Paper	Periods Per Hr/Week/Sem			Evaluation Scheme				Subject Total	Credit	Total Credit
				L	T	P	CT	TA	Total	ESE			
THEORY													
1	PY401	Mathematical Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4
2	PY402	Classical Mechanics	Core	3	1	0	40	20	60	40	100	3:1:0	4
3	PY403	Quantum Mechanics-I	Core	3	1	0	40	20	60	40	100	3:1:0	4
4	PY404	Statistical Mechanics- I	Core	3	1	0	40	20	60	40	100	3:1:0	4
5	PY405	Solid State Electronics	Core	3	1	0	40	20	60	40	100	3:1:0	4
PRACTICAL													
6	PY406	General and Optics Lab	Core	0	0	9	40	20	60	40	100	0:0:4	4
			Total	**15**	**5**	**9**	**240**	**120**	**360**	**240**	**600**	**24**	**24**

2nd Semester

S. No.	Course Code	Course Title	Type of Paper	Periods Per Hr/Week/Sem			Evaluation Scheme				Subject Total	Credit	Total Credit
				L	T	P	CT	TA	Total	ESE			
THEORY													
1	PY407	Quantum Mechanics-II	Core	3	1	0	40	20	60	40	100	3:1:0	4
2	PY408	Electromagnetic Theory	Core	3	1	0	40	20	60	40	100	3:1:0	4
3	PY409	Condensed Matter Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4
4	PY410	Nuclear and Particle Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4
5	PY411	Digital Electronics	Core	3	1	0	40	20	60	40	100	3:1:0	4
PRACTICAL													
6	PY412	Programming and Condensed Matter Physics Lab	Core	0	0	9	40	20	60	40	100	0:0:4	4
			Total	**15**	**5**	**9**	**240**	**120**	**360**	**240**	**600**	**24**	**24**

3rd Semester

S. No.	Course Code	Course Title	Type of Paper	Periods Per Hr/Week/Sem			Evaluation Scheme				Subject Total	Credit	Total Credit
				L	T	P	CT	TA	Total	ESE			
THEORY													
1	PY501	Atomic and Molecular Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4
2	PY502	Electronics Instrumentation	Core	3	1	0	40	20	60	40	100	3:1:0	4
3	PY503	Advanced Condensed Matter Physics	Core	3	1	0	40	20	60	40	100	3:1:0	4
4	PY504	Communication Electronics	Core	3	1	0	40	20	60	40	100	3:1:0	4
5	PY505	Numerical Techniques and Statistical Mechanics-II	Core	3	1	0	40	20	60	40	100	3:1:0	4
PRACTICAL													
6	PY506	Electronics Lab	Core	0	0	9	40	20	60	40	100	0:0:4	4
			Total	**15**	**5**	**9**	**240**	**120**	**360**	**240**	**600**	**24**	**24**

4th Semester

S. No.	Course Code	Course Title	Type of Paper	Periods Per hr/week/sem			Evaluation Scheme				Subject Total	Credit	Total Credit
				L	T	P	CT	TA	Total	ESE			
THEORY													
1		Elective-I	Elective-I	3	1	0	40	20	60	40	100	3:1:0	4
2		Elective-II	Elective-II	3	1	0	40	20	60	40	100	3:1:0	4
PRACTICAL													
3	PY507	Physics Seminar	Core	0	1	3	0	0	0	100	100	0:0:4	4
4	PY508	Physics Project*	Core	Three Months			0	0	0	300	300	0:0:8	8
			Total	**6**	**3**	**3**	**80**	**40**	**120**	**480**	**600**	**20**	**20**

List of Elective papers for IV Semester: A student has to choose any two elective papers from following electives.

1. Physics of Nanomaterials PY509
2. Bio-Physics PY510
3. Computational Methods and Programming in 'C' Language PY511
4. Laser Physics PY512
5. Microprocessor and its Applications PY513
6. Renewable Energy Resources PY514

CT= Class Test, **TA**= Teacher's Assessment, **ESE**= End Semester Examination; **Sessional**=CT+TA; **Subject Total**=Sessional + ESE;

Total Credit=24+24+24+20=92

***The Evaluation scheme for the Physics Project:**

Course Title	Course Code	Dissertation	Presentation	Viva/Discussion	Total
Physics Project	PY508	200	50	50	300

SYLLABI
SEMESTER – I

1.Name of the Department: Physics						
2.Course Name	**Mathematical Physics**			**L**	**T**	**P**
3.Course Code	**PY401**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart advanced knowledge of mathematical methods used in different disciplines of physics.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Given square, symmetric or Hermitian matrices, the students will be able to determine their rank, inverse, adjoint, eigenvalue, eigenvectors and perform other related operations.
CO2	For given mathematical functions satisfying per-requisite conditions, students will be able to perform their Laplace transform, Inverse Laplace transform, Fourier transform, Inverse Fourier transform and expand them in Fourier series.
CO3	For given complex functions, students will be able to identify their analytic behavior, classify different singularities, evaluate integrals using analytic continuation, Cauchy integral theorem, residue theorem and using gamma function.
CO4	Determine the series solution of Linear ordinary differential equations and second-order differential equations by power method and Frobenius method.
CO5	Explain the types, properties and symmetries of the groups and obtain their representations and multiplication table.

10.Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Matrices**

Linear vector spaces, matrix spaces, linear operators, eigenvectors and eigenvalues, matrix diagonalization, special matrices

Unit-2	**Number of lectures = 08**	**Title of the unit: Integral Transforms and Fourier Series**

Laplace Transform: properties of LT., shifting theorems on LT, LT of derivatives, Derivatives of LT., LT. of integrals, integration of LT, initial and final value theorems, inverse LT. by partial fractions, Fourier Series, Dirichlet's conditions, determination of Fourier coefficients, FS for arbitrary period, half-wave expansions, Fourier integral theorem, Fourier sine and cosine transforms, Fourier Transforms of Dirac Delta function, simple problems.

Unit-3	**Number of lectures = 08**	**Title of the unit: Complex Analysis**

Analytic functions, Cauchy-Riemann conditions, classification of singularities, Cauchy's theorem, Taylor and Laurent expansions, analytic continuation, residue theorem, evaluation of definite integrals, summation of series, gamma function.

Unit-4	**Number of lectures = 08**	**Title of the unit: Differential Equations and Special Functions**

Linear ordinary differential equations and their singularities, series solution of second- order equations, Legendre's polynomial, Hermite polynomial, Laguerre and Bessel functions, classical polynomials, Sturm-Liouville problem, expansion in orthogonal functions, wave and heat equations in 2D and 3D.

Unit-5	**Number of lectures = 08**	**Title of the unit: Group Theory**

Symmetries and groups, multiplication table and representations, Isomorphism and Homomorphism, permutation group, translation and axial rotation groups, SO (2), SO (3), SU(2), lie algebra and representation of a lie group, translation group and reciprocal lattice.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Given square, symmetric or Hermitian matrices, the students will be able to determine their rank, inverse, adjoint, eigenvalue, eigenvectors and perform other related operations.	**2**	**1**	**2**		**2**		**2**
CO2	For given mathematical functions satisfying per-requisite conditions, students will be able to perform their Laplace transform, Inverse Laplace transform, Fourier transform, Inverse Fourier transform and expand them in Fourier series.	**3**	**2**	**1**		**1**		**2**
CO3	For given complex functions, students will be able to identify their analytic behavior, classify different singularities, evaluate integrals using analytic continuation, Cauchy integral theorem, residue theorem and using gamma function.	**2**	**1**	**2**		**2**		**1**
CO4	Determine the series solution of Linear ordinary differential equations and second-order differential equations by power method and Frobenius method.	**3**	**1**	**2**		**1**		**1**
CO5	Explain the types, properties and symmetries of the groups and obtain their representations and multiplication table.	**3**	**2**	**3**	**1**	**3**	**1**	**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12.Brief description of self learning/E-learning component

1. **https://www.freebookcentre.net/Physics/Mathematical-Physics-Books.html**
2. **https://nptel.ac.in/courses/115106086/**
3. **www.youtube.com**

13. Books recommended:

1. G.B. Arfken, *Mathematical Methods for Physicists*.
2. P. Dennery and A. Krzywicki, *Mathematics for Physicists.*
3. P.K. Chattopadhyay, *Mathematical Physics.*
4. A.W. Joshi, *Matrices and Tensors in Physics*.
5. R.V. Churchill and J.W. Brown, *Complex Variables and Applications.*
6. P.M. Morse and H. Feshbach, *Methods of Theoretical Physics (Volume I and II).*

1.Name of the Department: Physics						
2.Course Name	**Classical Mechanics**			**L**	**T**	**P**
3.Course Code	**PY402**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge of classical physics, the Newtonian physics. Despite many modern theories the Newtonian mechanics remain essential part of every single in daily life. After successful completion of course, the student will able to utilize the classical mechanics to the level of its validity.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of the Newtonian mechanics and the limitation of it which introduce the concept of classical mechanics.
CO2	Students will be able to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.
CO3	students will gain an understanding of two-particle central force problem in relative and centre of mass coordinates, derive Kepler's planetary laws of motion and scattering in central force problem which develop a deep understanding of planetary motion.
CO4	Students will create the own understanding of small oscillations which helps them to find frequency of small oscillations.
CO5	Students will be able to understand, what is the need of quantum mechanics? And the mathematics formulated as applied to physics.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Preliminaries

Newtonian mechanics of one and many particle systems, Simple Pendulum with rigid support, Two connected masses with string passing over a pully, Virtual work, Rolling mass inside or outside a circular ring, Constraints; their classification, D'Alembert's principle, generalized coordinates.

Unit-2	Number of lectures = 08	Title of the unit: Lagrangian and Hamiltonian Formulations of Mechanics

Calculus of variations, Hamilton's principle of least action, Lagrange's equations of motion, conservation laws, systems with a single degree of freedom, rigid body dynamics, symmetrical top, Hamilton's equations of motion, phase plots, fixed points and their stabilities.

Unit-3	Number of lectures = 08	Title of the unit: Two-Body Central Force Problem

Equation of motion and first integrals, classification of orbits, Kepler problem, scattering in central force field.

Unit-4	Number of lectures = 08	Title of the unit: Small Oscillations

Concept of small oscillations, Expression of kinetic energy and potential energy for the problem of small oscillations, Frequencies of free vibration, and Normal coordinates. Linearization of equations of motion. Vibrations of coupled systems, vibrations of tri- atomic molecule.

Unit-5	Number of lectures = 08	Title of the unit: Hamiltonian Mechanics and Chaos

Canonical transformations, Poisson brackets, Hamilton-Jacobi theory, action-angle variables, perturbation theory, integrable systems, introduction to chaotic dynamics.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to use Newton's laws of motion to solve advanced problems involving the dynamic motion of classical mechanical systems	**2**	**2**	**1**	**3**	**2**	**1**	**1**
CO2	Students will be able to represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations of classical mechanics.	**3**	**1**	**2**	**1**	**3**	**1**	
CO3	Students will gain a deep understanding of planetary motion.	**2**	**3**	**2**	**2**	**3**	**2**	**1**
CO4	Students will create the own understanding approaches to the finding the frequency of small oscillations.	**3**	**1**	**2**	**1**	**2**	**1**	
CO5	Students will gain knowledge about the concepts and mathematically formulated as applied to physics	**3**	**2**	**1**	**1**	**2**	**2**	**2**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/105/115105098/
2. https://nptel.ac.in/courses/115/106/115106068/
3. https://nptel.ac.in/courses/122/106/122106027/

13. Books recommended:

1. H. Goldstein, *Classical Mechanics.*
2. L.D. Landau and E.M. Lifshitz, *Mechanics.*
3. I.C. Percival and D. Richards, *Introduction to Dynamics*.
4. J.V. Jose and E.J. Saletan, *Classical Dynamics: A Contemporary Approach.*
5. E.T. Whittaker, *A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.*
6. N.C. Rana and P.S. Joag, *Classical Mechanics*.

1.Name of the Department: Physics						
2.Course Name	**Quantum Mechanics-I**			**L**	**T**	**P**
3.Course Code	**PY403**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: This Course offers a systematic introduction to fundamental non-relativistic quantum mechanics. After successful completion of course, the student will able to work on the postulates of quantum mechanics for physical systems.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Would be able to analyze the inadequacies of classical mechanics in atomic domain and provide the understanding of probabilistic outcomes in quantum mechanics. Would be able to represent a problem in state vector notion.
CO2	To analyse the central concepts and principles in quantum mechanics, such as the Schrödinger equation.
CO3	To solve the Schrodinger's equation for time independent problems like free particle, particle in an infinite potential well, square potential well, the step potential and potential barrier and the simple harmonic oscillator. Applying ladder operators to solve the quantum mechanical problems.
CO4	To analyze the structure of the hydrogen atom and show an understanding of quantisation of angular momentum.
CO5	Would be able to apply the symmetry operations and basis transformations.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction

Linear vector Space, Empirical basis, wave-particle duality, electron diffraction, notion of state vector and its probability interpretation

Unit-2	Number of lectures = 08	Title of the unit: Structure of Quantum Mechanics

Operators and observables, significance of eigen functions and eigenvalues, commutation relations, uncertainty principle, measurement in quantum theory.

Unit-3	Number of lectures = 08	Title of the unit: Quantum Dynamics

Time-dependent Schrödinger equation, stationary states and their significance, time- independent Schrödinger equation. Free-particle solution, wave packets, particle in a square well potential, transmission through a potential barrier, simple harmonic oscillator by wave equation and operator methods, charged particle in a uniform magnetic field, coherent states.

Unit-4	Number of lectures = 08	Title of the unit: Spherically Symmetric Potentials

Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.

Unit-5	Number of lectures = 08	Title of the unit: Symmetry in Quantum Mechanics

Symmetry operations and unitary transformations, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Would be able to analyze the inadequacies of classical mechanics in atomic domain and provide the understanding of probabilistic outcomes in quantum mechanics. Would be able to represent a problem in state vector notion.	**2**	**2**		**1**	**1**		**1**
CO2	To analyse the central concepts and principles in quantum mechanics, such as the Schrödinger equation.	**3**	**1**	**1**		**1**		**2**
CO3	To solve the Schrodinger's equation for time independent problems like free particle, particle in an infinite potential well, square potential well, the step potential and potential barrier and the simple harmonic oscillator. Applying ladder operators to solve the quantum mechanical problems.	**2**	**1**	**2**	**2**	**3**		**3**
CO4	To analyze the structure of the hydrogen atom and show an understanding of quantisation of angular momentum.	**3**	**2**	**3**		**1**		**2**
CO5	Would be able to apply the symmetry operations and basis transformations.	**3**	**1**		**2**	**2**		**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/102/115102023/
2. https://nptel.ac.in/courses/115/104/115104096/
3. https://nptel.ac.in/courses/115/103/115103104/
4. https://nptel.ac.in/courses/115/101/115101107/

13. Books recommended:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume I).*
2. L.I. Schiff, *Quantum Mechanics.*
3. E. Merzbacher, *Quantum Mechanics.*
4. R.P. Feynman, *Feynman Lectures on Physics (Volume 3).*
5. A. Messiah, *Quantum Mechanics (Volume I).*
6. R. Shankar, *Principles of Quantum Mechanics.*

1.Name of the Department: Physics						
2.Course Name	**Statistical Mechanics-I**			**L**	**T**	**P**
3.Course Code	**PY404**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge of Statistical Mechanics. By using the principles of physics and mathematics students will be able to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of basic tools of statistics, their significance and practical applications in different domains of real life.
CO2	Students will be able to apply the basic and advance mathematical concepts to solve the problems of thermodynamics.
CO3	Students will gain understanding of fundamental concepts of classical statistical mechanics and apply them to solve thermodynamical problems from statistical point of view.
CO4	Students will develop their own understanding of quantum statistical mechanics and solve the problems associated with the systems obeying Bose-Einstein statistics.
CO5	Students will be able to apply their knowledge to deal with the problems of the systems obeying Fermi-Dirac statistics.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Elementary Probability Theory

Random variables, mean, variance and standard deviations, Binomial, Poisson and Gaussian distributions, central limit theorem. problems

Unit-2	Number of lectures = 08	Title of the unit: Review of Thermodynamics

Basic postulates of thermodynamics, Extensive and intensive variables The Euler Equation, The Gibbs-Duhem relation, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) Electromagnetic radiation.

Unit-3	Number of lectures = 08	Title of the unit: Formalism of Equilibrium Statistical Mechanics

Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles; microcanonical, canonical, grand canonical, and NPT ensembles and their connection to thermodynamic variables, fluctuations in energy density and no. of particles in various ensembles, applications of various ensembles, statistical mechanics of a system of harmonic oscillators, equation of state for a non-ideal gas, Vander Waals' equation of state, Meyer cluster expansion, Virial coefficients.

Unit-4	Number of lectures = 08	Title of the unit: Quantum Statistics-1

The density matrix, application of quantum statistics to (i) an electron in a magnetic field (ii) A free particle in a box (iii) and a linear harmonic oscillator. Bose-Einstein statistics, applications of the formalism to; Ideal Bose gas, Debye theory of specific heat of solids, thermodynamics of black-body radiation, Bose-Einstein condensation, experimental studies on atomicBEC.

Unit-5	Number of lectures = 08	Title of the unit: Quantum Statistics-2

Fermi-Dirac statistics, Thermodynamic behavior of Ideal Fermi gas, thermionic emission, photoelectric emission, Pauli paramagnetism, electronic specific heat, white dwarf stars, mass radius relationship, Chandrashekhar limit.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of basic tools of statistics, their significance and practical applications in different domains of real life.	**2**	**2**	**1**	**2**	**2**	**3**	**1**
CO2	Students will be able to apply the basic and advance mathematical concepts to solve the problems of thermodynamics	**3**	**3**	**2**		**3**	**1**	**3**
CO3	Students will gain understanding of fundamental concepts of classical statistical mechanics and apply them to solve thermodynamical problems from statistical point of view.	**2**	**1**	**1**		**2**	**3**	**2**
CO4	Students will develop their own understanding of quantum statistical mechanics and solve the problems associated with the systems obeying Bose-Einstein statistics.	**3**	**2**	**3**		**1**	**1**	**3**
CO5	Students will be able to apply their knowledge to deal with the problems of the systems obeying Fermi-Dirac statistics.	**2**	**3**	**2**		**2**	**1**	**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/103/115103113/
2. https://nptel.ac.in/courses/115/106/115106111/
3. https://youtu.be/D1RzvXDXyqA

13. Books recommended:

1. F. Reif, *Fundamentals of Statistical and Thermal Physics.*
2. K. Huang, *Statistical Mechanics.*
3. R.K. Pathria, *Statistical Mechanics.*
4. D.A. McQuarrie, *Statistical Mechanics.*
5. S.K. Ma, *Statistical Mechanics.*

1. Name of the Department: Physics						
2. Course Name	Solid State Electronics			L	T	P
3. Course Code	PY405			3	1	0
4. Type of Course (use tick mark)		Core (√)	Foundation Course ( )		Departmental Elective ( )	
5. Pre-requisite (if any)	B.Sc. with Physics and Mathematics	6. Frequency (use tick marks)	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: To understand the fundamental principle of Solid State Physics. To learn about the relationship between electron transport properties and operation of semiconductor devices. To learn the working and use of different types of diodes. To learn the analysis of different BJT configurations and Biasing methods

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students shall be able to Apply the fundamental principle of Quantum Mechanics and Solid State Physics to understand the parameters of semiconductor materials also able to describe the relationship between electron transport properties and operation of semiconductor devices.
CO2	Students will be familiar with the working and use of different types of diodes, able to discuss the concepts of various biasing methods for BJT also able to Analyze the BJT configurations.
CO3	Students shall be able to Investigate the different configuration and obtain the device small signal model of BJTs, Analysis of a Transistor amplifier circuit using h parameters.
CO4	Students will be familiar with the construction and characteristics of JFET, transfer characteristic and Analyze the FET Biasing concepts, FET and MOSFET amplifier, small signal analysis.
CO5	Students shall be able to analyze and compare the features of different power electronic devices like SCR, UJT etc.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Conduction Mechanism in Metals & Semiconductors

Mobility and conductivity, Density of states, Equilibrium concentration of electrons and holes- the Fermi level and energy distribution of carriers inside the bands- temperature dependence of carrier concentration inside the bands - Carrier transport in semiconductors - drift of carriers in electric fields, carrier flow by diffusion - constancy of Fermi level across junction, recombination, Einstein relation, continuity equation.

Unit-2	Number of lectures =08	Title of the unit: Junction Devices

Theory of PN junction diode, Zener diode , Photodiode, Tunnel diode, PIN diode and Varactor diode, GUNN diode, Transistor biasing, CB, CE, CC configurations, Input output characteristics, Early Effect, Graphical analysis of the CE configuration, Thermal stabilization, The operating point, Bias stability

Unit-3	Number of lectures = 08	Title of the unit: Transistor Models

Transistor hybrid model, h parameters, Analysis of a Transistor amplifier circuit using h parameters, Measurement and graphical determination of h parameters, Hybrid π model, The re transistor model, Ebers-Moll models.

Unit-4	Number of lectures = 08	Title of the unit: Field Effect Transistors

Construction and characteristics of JFET, transfer characteristic, The FET small signal model, Measurement of gm and rd, JFET fixed bias, Self bias and voltage divider configurations, Use of FET as voltage controlled resistor, JFET source follower (common Drain) configuration, JFET Common – Gate configuration, Depletion and enhancement type MOSFETs

Unit-5	Number of lectures = 08	Title of the unit: Power Electronics

SCR: Its operation, characteristics, SCR as Series Static switch, variable resistance phase controller, battery charging regulator, as a temperature controller, as emergency lighting system, as voltage sensor, as sawtooth generator, silicon controlled switch, light activated SCR, Shockley diode, Diac, Triac, UJT Characteristics

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students shall be able to Apply the fundamental principle of Quantum Mechanics and Solid State Physics to understand the parameters of semiconductor materials also able	2	2	2		2	1	
CO2	Students will be familiar with the working and use of different types of diodes, able to discuss the concepts of various biasing methods for BJT also able to Analyze the BJT	3	3	3		1	2	1
CO3	Students shall be able to Investigate the different configuration and obtain the device small signal model of BJTs, Analysis of a Transistor amplifier circuit using h	2	1	1	3	2	1	2
CO4	Students will be familiar with the construction and characteristics of JFET, transfer characteristic and Analyze the FET Biasing concepts, FET and MOSFET amplifier,	3	2	3	1	1		
CO5	Students shall be able to analyze and compare the features of different power electronic devices like SCR, UJT etc.	2	3	2	2	2		1

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

1. https://nptel.ac.in/courses/117/103/117103063/
2. https://nptel.ac.in/courses/108/102/108102095/
3. https://nptel.ac.in/courses/108/102/108102145/

13. Books recommended:

1. Solid State Electronic Devices by B.G. Streetman
2. Electronic Devices and Circuit Theory by R.L. Boylested and L. Nashelsky
3. Integrated Electronics by J. Millman and C.C. Halkias
4. Introduction to Semiconductor Devices by M. S. Tyagi

1. Name of the Department: Physics						
2. Course Name	**General and Optics Lab**			**L**	**T**	**P**
3. Course Code	**PY406**			0	0	9
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5. Pre-requisite (if any)	BSc Physics with Mathematics	**6. Frequency (use tick marks)**	Even **( )**	Odd **(√)**	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 00		**Tutorials = 00**	**Practical = 10**			

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart practical knowledge/measurements in optics and electronics.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Design and analyze the DC bias circuitry of BJT and FET also able to Design biasing circuits using diodes and transistors.
CO2	Implement the fundamental concepts and techniques in digital electronics. Utilize the various combinational circuits and their application in digital electronics.
CO3	An ability to design the circuits with basic power devices, measuring instruments & power supplies that serves many practical purposes.
CO4	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results

10. Syllabus

Exp-01	To determine the wavelength of prominent lines of mercury with the help of reflection grating.
Exp-02	(a) To plot the power distribution of a laser beam. (b) To determine the divergence of a given laser source.
Exp-03	The study of elliptically and circularly polarized light with help of Babinet's compensator.
Exp-04	To determine the thickness of air film between glass plates, the integral part of the order of fringes at the center and the fractional part, if any, in an Etalon.
Exp-05	To verify Fresnel's formula of reflection for plane polarized light and to determine Brewster's angle for glass.
Exp-06	To study the transfer characteristics of UJT and FET.
Exp-07	To study the design of CE Amplifier.
Exp-08	To study the design of Regulated Power Supply.
Exp-09	Determination of band gap of semiconductor from temperature dependence of resistivity using Four Probe Method.
Exp-10	Design of simple logic gates using transistors.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Design and analyze the DC bias circuitry of BJT and FET also able to Design biasing circuits using diodes and transistors.	**2**	**2**	**2**	**1**	**2**	**1**	**1**
CO2	Implement the fundamental concepts and techniques in digital electronics. Utilize the various combinational circuits and their application in digital electronics.	**3**	**3**	**2**		**1**	**1**	**2**
CO3	An ability to design the circuits with basic power devices, measuring instruments & power supplies that serves many practical purposes.	**2**	**2**	**3**	**1**	**2**		**3**
CO4	Develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results	**3**	**2**	**1**		**1**		**1**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

1. https://circuitdigest.com/electronic-circuits/designing-and-gate-using-transistors
2. https://www.circuitstoday.com/characteristics-of-jfets
3. https://www.youtube.com/watch?v=HG22Y0KrvI0
4. http://www.rossnazirullah.com/BSc/BSc.htm

13. Books recommended:

1. Hand book of electronics by V. Kumar
2. Modern Digital Electronics by R.P.Jain
3. Practical physics by Kumar P.R.S., PHI learning private limited

SYLLABI
SEMESTER – II

1.Name of the Department: Physics						
2.Course Name	**Quantum Mechanics II**			**L**	**T**	**P**
3.Course Code	**PY407**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures=30	Tutorials=10	Practical=Nil

8. COURSE OBJECTIVES: This course is aimed at providing a comprehensive review of the core concepts of quantum mechanics through problem solving and introducing some advanced topics with illustrative examples.

9. COURSE OUTCOMES (CO):
After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Ability to solve problems related to angular momentum and determine the coefficients corresponding to addition of angular momentum.
CO2	Students can account for the phenomena involved in the Zeeman effect and spin-orbit coupling, what is meant by identical particles and quantum statistics, and they will be able to perform calculations on systems of identical particles.
CO3	Students will be able to develop the solution of actual or perturbed problems based on exact problems or Hamiltonians.
CO4	Analysis of scattering and differential cross section of wave packets.
CO5	Students will be able to solve Dirac's equation. They will be able to analyse the spin orbit interaction comprehensively.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Angular Momentum

Rotation operators, angular momentum algebra, eigenvalues of J^2 and J_Z, Matrix representation of S_X, S_Y, S_Z, J_X, J_Y, J_Z, J^2, spinors and Pauli matrices, addition of angular momenta, Clebsch-Gordon coefficients.

Unit-2	Number of lectures = 08	Title of the unit: Identical Particles and Time-independentApproximationMethods

Indistinguishability, symmetric and anti-symmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle. Non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, variational methods, WKB method, tunnelling.

Unit-3	Number of lectures = 08	Title of the unit: Time-dependent Problems

Schrödinger and Heisenberg picture, time-dependent perturbation theory, transition probability calculations, golden rule, adiabatic approximation, sudden approximation, beta decay as an example.

Unit-4	Number of lectures = 08	Title of the unit: Scattering Theory

Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

Unit-5	Number of lectures = 08	Title of the unit: Relativistic Quantum Mechanics

Klein-Gordon equation, Dirac equation and its plane wave solution, Significance of negative energy solutions, Spin angular momentum of the Dirac particle, Electron in EM fields, Spin- orbit interaction, Dirac equation for a particle in a central force field.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Ability to solve problems related to angular momentum and determine the coefficients corresponding to addition of angular momentum.	**3**	**2**	**1**	**1**	**1**		**3**
CO2	Students can account for the phenomena involved in the Zeeman effect and spin-orbit coupling, what is meant by identical particles and quantum statistics, and they will be able to perform calculations on systems of identical particles.	**2**	**1**	**2**		**2**	**1**	**2**
CO3	Students will be able to develop the solution of actual or perturbed problems based on exact problems or Hamiltonians.	**3**	**1**	**3**	**1**	**1**		**1**
CO4	Analysis of scattering and differential cross section of wave packets.	**2**		**2**		**1**	**2**	**2**
CO5	Students will be able to solve Dirac's equation. They will be able to analyse the spin orbit interaction comprehensively.	**3**		**1**		**3**		**2**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

5. https://nptel.ac.in/courses/115/103/115103104/
6. https://nptel.ac.in/courses/115/102/115102023/
7. https://nptel.ac.in/courses/115/108/115108074/

13. Books recommended:

1. C. Cohen-Tannoudji, B. Diu and F. Laloe, *Quantum Mechanics (Volume II).*
2. A. Messiah, *Quantum Mechanics (Volume II).*
3. Flügge, *Practical Quantum Mechanics.*
4. J.J. Sakurai, *Modern Quantum Mechanics.*
5. K. Gottfried, *Quantum Mechanics.*

1.Name of the Department: Physics						
2.Course Name	**Electromagnetic Theory**			**L**	**T**	**P**
3.Course Code	**PY408**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge basic skills required to understand electromagnetic theory and emphasis on the inter-relationship between Electricity and Magnetism. By using the principal of physics and mathematics to obtain quantitative relations which are very important for higher studies. After successfully completion of course, the student will be able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will impart knowledge on the concepts of electrostatics, electric potential, energy density and their applications and understand the basic mathematical concepts related to electromagnetic vector fields.
CO2	Students will be able understand the methods for solving boundary value problems for magnetic field and to evaluate the Biot-Savat law, Ampere's law.
CO3	Students will gain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic fields problems.
CO4	Students will gain an understanding of laws governing electrodynamics, plane wave propagation in different media, power flow, polarization, transmission and reflection at an interface, transmission lines, waveguides.
CO5	Students will understand the fundamental equations acquire a sense of unity in physics at a fundamental level by embracing the concepts of special relativity as emerged through the laws of electrodynamics and equipped with the necessary mathematical concepts to be able to solve relative problems.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Electrostatics

Differential equation for electric field, Poisson and Laplace equations, formal solution for potential with Green's functions, boundary value problems, examples of image method and Green's function method, solutions of Laplace equation in cylindrical and spherical coordinates by orthogonal functions, dielectrics, polarization of a medium, electrostatic energy.

Unit-2	Number of lectures = 08	Title of the unit: Magnetostatics

Biot-Savart law, differential equation for static magnetic field, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.

Unit-3	Number of lectures = 08	Title of the unit: Maxwell's Equations

Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution.

Unit-4	Number of lectures = 08	Title of the unit: Electromagnetic Waves

Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.

Unit-5	Number of lectures = 08	Title of the unit: Radiation and Covariant Formulation of Electrodynamics

Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, antenna, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula. Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will apply the principles of electrostatics to the solutions of problems relating to electric field and electric potential, boundary conditions and electric energy density.	**2**	**1**	**1**		**2**	**1**	**2**
CO2	Students will be able to apply the principles of magneto statics to the solutions of problems relating to magnetic field and magnetic potential, boundary conditions and magnetic energy density.	**3**	**1**	**2**	**1**	**3**		**3**
CO3	Students will understand the concepts related to Faraday's law, induced emf and Maxwell's equations.	**2**	**3**	**2**		**3**	**2**	**2**
CO4	Students will Apply Maxwell's equations to solutions of problems relating to transmission lines and uniform plane wave propagation.	**3**		**1**	**1**	**2**		**1**
CO5	Students will formulate and solve electrodynamic problems in relativistically covariant form in four-dimensional space-time.	**1**	**2**	**1**	**2**	**2**	**1**	

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/101/115101004/
2. https://nptel.ac.in/courses/115/104/115104088/
3. https://nptel.ac.in/courses/115/106/115106122/

13. Books recommended:

1. J.D. Jackson, *Classical Electrodynamics.*
2. D.J. Griffiths, *Introduction to Electrodynamics.*
3. J.R. Reitz, F.J. Milford and R.W. Christy, *Foundations of Electromagnetic Theory.*
4. W.K.H. Panofsky and M. Phillips, *Classical Electricity and Magnetism.*
5. F.F. Chen, *Introduction to Plasma Physics and Controlled Fusion.*

1.Name of the Department: Physics						
2.Course Name	**Condensed Matter Physics**			**L**	**T**	**P**
3.Course Code	**PY409**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )
7.Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES: This course aims to establish fundamental concepts in condensed matter physics and applies the physics you have learned previously (in particular quantum mechanics, classical mechanics, electromagnetism and statistical mechanics) to these real-world materials.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Examine the electric and thermal transport phenomena in solids based on the free electron theory.
CO2	Conceptualize the different types of bonds that exists in nature, the problem of X-ray diffraction and appreciate the beauty of Bragg's treatment along with the contribution of Von Laue and Miller in solving it.
CO3	Students will understand the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.
CO4	Students will create the own understanding of molecular vibrations in determining thermal properties of materials.
CO5	Explain the origin of superconducting and magnetic properties of materials and compare on the basis of quantum theory.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Free Electron Theory and Transport Phenomena in solids

Drude theory, Review of Sommerfeld model of Free electron gas, critique of free-electron model, Boltzmann Transport Equations, Electrical and Thermal Conductivity of metals, Wiedemann-Franz law, Hall effect and magneto-resistance, Thermo-electric effects.

Unit-2	Number of lectures = 08	Title of the unit: Bonding in Solids and Crystal Lattices

Bond classifications: Nature of bonding, ionic crystals, cohesive energy and Madelung Constant, covalent, molecular and hydrogen bonding. Bravais lattices and their classification. Symmetry operations, reciprocal lattice,X-raydiffraction,Bragg'slaw,VonLaue'sformulation,Millerindices,relationbetweenMillerIndicesof a family of planes and inter planar spacing.

Unit-3	Number of lectures = 08	Title of the unit: Band Theory of Solids

Energy spectra in atoms, molecules and solids, formation of energy bands, comparative picture of bands structure of metals, semiconductors and insulators. Electron wave equation in a periodic potential (Bloch theorem), Kronig Penney model. Motion of electron in a one dimensional periodic potential, crystal momentum and effective mass. Brillouin zones and Fermi surface. Cyclotron Resonance and De Hass Van Alphen Effect.

Unit-4	Number of lectures = 08	Title of the unit: Lattice Dynamics

Wave motion of one dimensional atomic lattice, group velocity and phase velocity, vibrations of a one dimensional lattice with two atoms per primitive cell, normal modes of vibrations, density of states, quantization of vibrations (Phonons), inelastic scattering of photons by long wavelength phonons. Thermal properties of solids: Specific heat, Dulong Pettit's law, Einstein and Debye model of specific heat.

Unit-5	Number of lectures = 08	Title of the unit: Magnetism and Superconductivity

Origin of magnetism, classical theory of diamagnetism and paramagnetism, ferromagnetism, hysteresis, energy loss, Curie law, Weiss theory of ferromagnets and Curie-Weiss law. Superconductivity: Thermodynamics of superconductors, London's equation and Meissner effect, Type-I and Type-II superconductors.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Examine the electric and thermal transport phenomena in solids based on the free electron theory.	**2**	**3**	**1**		**2**	**2**	**3**
CO2	Conceptualize the different types of bonds that exists in nature, the problem of X-ray diffraction and appreciate the beauty of Bragg's treatment along with the contribution of Von Laue and Miller in solving it.	**2**	**3**	**2**	**1**	**2**	**2**	**2**
CO3	Students will understand the role of electronic energy band structures of solids in governing various electrical and optical properties of materials.	**3**	**1**	**2**		**3**	**1**	
CO4	Students will create the own understanding of molecular vibrations in determining thermal properties of materials.	**2**	**1**	**1**		**2**	**1**	**2**
CO5	Explain the origin of superconducting and magnetic properties of materials and compare on the basis of quantum theory.	**3**	**3**	**2**		**2**	**2**	**3**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/103/115103102/
2. https://nptel.ac.in/courses/115/106/115106061/
3. https://nptel.ac.in/courses/115/105/115105099/

13. Books recommended:

1. C. Kittel, *Introduction to Solid State Physics.*
2. N.W. Ashcroft and N.D. Mermin, *Solid State Physics.*
3. J.M. Ziman, *Principles of the Theory of Solids.*
4. A.J. Dekker, *Solid State Physics.*
5. G. Burns, *Solid State Physics.*
6. M.P. Marder, *Condensed Matter Physics.*

1.Name of the Department: Physics						
2.Course Name	**Nuclear and Particle Physics**			**L**	**T**	**P**
3.Course Code	**PY410**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge of Nuclear Physics. By using the basic principles of Nuclear Physics and its fundamentals reactions to obtain quantitative relations which are very important for higher studies and its applications. After successfully completion of course, the student will be able explore the subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of the basic Nuclear properties and Nuclear forces involved in the formation of a nucleus.
CO2	Students will be able to develop a deep understanding of various phenomena of Nuclear Reactions, Type of reactions and counters and detectors.
CO3	Students will gain an understanding of the different nuclear models and decay theories.
CO4	Students will be able to understand the classification and properties of elementary particles various types of interactions and conservation rules in fundamental interactions.
CO5	Students will gain an understanding of approaches to the Particle Physics, Strange particles and its conservation.

10.Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Basic Nuclear properties and Nuclear forces**

Mass, Charge, and Constituents of the nucleus, Nuclear size and distribution of nucleons, Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Characteristics of nuclear forces -Range and strength, Ground and exited states of deuteron, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces. Scattering length, Yukawa hypothesis.

Unit-2	**Number of lectures = 08**	**Title of the unit: Nuclear reactions and Detectors**

Nuclear Reactions and Cross sections, Type of reactions and Conversation laws. Q- valueand its significance. Resonance: Breit-Wigner Dispersion Formula, The compound Nucleus, Statistical theory of Nuclear Reactions, Geiger-Muller Counter, Semiconductor detectors.

Unit-3	**Number of lectures = 08**	**Title of the unit: Nuclear disintegration and models**

Review of the Semi-empirical mass formula, Liquid drop model, Single particle Shell model. Tunneling theory of alpha decay, Fermi theory of Beta decay, inverse beta process, Double- beta decay, Different types of neutrinos: the two neutrino experiment, The neutrino helicity, Gamma decay, Fermi and Gammow- Teller selection rules.

Unit-4	**Number of lectures = 08**	**Title of the unit: Particle Physics I**

Classification and properties of elementary particles , Leptons, Baryons, mesons, particles and antiparticles, excited states and resonances, Various types of interactions, gravitational, electromagnetic, weak and strong interactions and their mediating quanta, Conservation rules in fundamental interactions.

Unit-5	**Number of lectures = 08**	**Title of the unit: Particle Physics II**

Charge symmetry and charge independence, Parity and charge conjugation, Conservation of parity and its violation in different types of interactions. Gell-Mann Nishijima formula, Strange particles, associated production, strangeness and decay modes of charged Kaons, Isospin and its conservation. Idea of eight fold way and quarks.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of the basic Nuclear properties and Nuclear forces involved in the formation of a nucleus.	**3**	**2**	**1**		**1**	**3**	**2**
CO2	Students will be able to develop a deep understanding of various phenomena of Nuclear Reactions, Type of reactions and counters and detectors.	**2**	**2**	**3**		**3**	**2**	**3**
CO3	Students will gain an understanding of the different nuclear models and decay theories.	**3**	**1**	**2**		**1**	**3**	**2**
CO4	Students will be able to understand the classification and properties of elementary particles various types of interactions and conservation rules in fundamental	**2**	**2**	**3**		**2**	**1**	**3**
CO5	Students will gain an understanding of approaches to the Particle Physics, Strange particles and its conservation.	**2**	**1**	**1**		**1**	**2**	**2**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://www.youtube.com/watch?v=H7OipY8RzX0andlist=PL0b6maW-5d1fvnUXykaaD0JPjEB0pTDF9
2. https://www.youtube.com/watch?v=FGxawF-k8andlist=PL0b6maW-5d1fvnUXykaaD0JPjEB0pTDF9andindex=4
3. https://www.youtube.com/watch?v=josqjcH79PEandlist=PLOTSXa-xycCWOswsVQrA6PmuXIBoS7tPw

13. Books recommended:

1. G.D. Coughlan and J.E. Dodd, *The Ideas of Particle Physics.*
2. D. Griffiths, *Introduction to Elementary Particles*.
3. D.H. Perkins, *Introduction to High Energy Physics.*
4. I. Kaplan, *Nuclear Physics.*
5. R.R. Roy and B.P. Nigam, *Nuclear Physics.*
6. M.A. Preston and R.K. Bhaduri, *Structure of the Nucleus.*
7. M.G. Bowler, *Nuclear Physics.*

1. Name of the Department: Physics						
2. Course Name	**Digital Electronics**			**L**	**T**	**P**
3. Course Code	**PY411**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5. Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6. Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )
7. Total Number of Lectures, Tutorials, Practicals						
Lectures = 30		**Tutorials = 10**		**Practical = Nil**		

8. COURSE OBJECTIVES:

1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
2. To prepare students to perform the analysis and design of various digital electronic circuits.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Student shall be able to understand the basics of operational amplifier (Op-Amp) along with examine, analyze and evaluate its various version including voltage source rectifiers and filters.
CO2	For the given logic families of integrated circuits, student shall be able to understand its specifications. Students would examine, analyze the DTL, TTL, MOSFET, CMOS and evaluate universal gates.
CO3	Given a number, students shall be able to represent various conversions in mathematical form. Student shall be able to analyze and evaluate various theorems and K- Map method and able to design various logic circuits.
CO4	For a given Combinational circuit and sequential circuits, student shall be able to understand its various building blocks and examine, analyze and evaluate adders, Subtractor, multiplexer, encoders, multivibrator, A/D and D/A converter and last able to design various logic circuits.
CO5	For a given 8085 microprocessor, student would be able to understand and analyze its architecture, Interfacing devices, Instruction set and programming.

10. Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Operational Amplifier Basic and Application**

Review of Feedback, Linear Circuit, Op-Amp Basic, Inverting and Non-inverting amplifiers, Unity follower, Summing amplifiers, Integrator, Differentiator, Op- Amp Specifications- DC Off- set parameter, Frequency parameters, Imperfection in Op- Amplifier application- multiple stage gain, Voltage summing and subtraction, Current controlled voltage source, Voltage controlled current source, Rectifiers and Limiters, Comparators and Schmitt Triggers, Active filters.

Unit-2	**Number of lectures =08**	**Title of the unit: Digital Logic Gates**

Symbols and truth tables, Classes of digital integrated circuits (Diode logic, DTL, TTL, ECL, MOSFET, CMOS), Transistor- Transistor Logic (TTL), Single Input TTL Inverter (transfer characteristic), Multi- collector transistors, Propagation delays, Diode Logic, DTL NAND Gate (transfer characteristic, noise immunity, fan out), Emitter Coupled Logic (transfer characteristic of OR/NOR gate, practical implementation, MOSFET Logic- Review of MOSFET, MOSFET Inverter with active load, MOSFET NOR and NAND gates, Complementary MOS (CMOS)-CMOS inverter, CMOS NOR and NAND, Power dissipation in CMOS, Advantages/Disadvantages of CMOS.

Unit-3	**Number of lectures = 08**	**Title of the unit: Digital Electronics and Logic Gate**

Binary, Octal, Hexadecimal number system, Base conversion system, Bipolar junction and Field Effect transistor as switches, Basic digital logic gates (OR, AND and NOT, NOR, NAND and Exclusive OR), XOR gate, Boolean laws and theorem, Sum of Product (SOP) and Peroduct of Sum (POS) method, Karnaugh map, pair, quad and octave, POS simplification, min term, max- term.

Unit-4	**Number of lectures = 08**	**Title of the unit: Application of Digital Logic Gate**

Half adder and Full adder circuit, multiplexers, demultiplexer, Flip- Flop and Registers- RS Flip Flop, D- Flip Flop, T- Flip Flop, JK- Flip Flop, JK Master- Slave Flip Flop, Astable, Monostable and Bi-stable multivibrator, types of registers, serial-in-serial out, serial-in-parallel out, parallel-in- serial out, parallel-in parallel out, Counters and Convertors- asynchronous and synchronous counter, Mod-3 and Mod-5 counters, shift counters, Digital-to Analog Converters-D/A converter, ladder network, A/D converters.

Unit-5	**Number of lectures = 08**	**Title of the unit: Microprocessor**

Intel 8085 microprocessor architecture, interfacing devices, BUS timing, instruction set, simple illustrative program

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Student shall be able to understand the basics of operational amplifier (Op-Amp) along with examine, analyze and evaluate its various version including voltage source rectifiers and filters.	**2**	**1**	**1**		**1**	**1**	
CO2	For the given logic families of integrated circuits, student shall be able to understand its specifications. Students would examine, analyze the DTL, TTL, MOSFET, CMOS and evaluate universal gates.	**3**	**2**	**2**	**1**	**2**	**1**	**1**
CO3	Given a number, students shall be able to represent various conversions in mathematical form. Student shall be able to analyze and evaluate various theorems and K- Map method and able to design various logic circuits.	**2**	**1**	**3**		**3**	**2**	**1**
CO4	For a given Combinational circuit and sequential circuits, student shall be able to understand its various building blocks and examine, analyze and evaluate adders, Subtractor, multiplexer, encoders, multivibrator, A/D and D/A converter and last able to design various logic circuits.	**3**	**3**	**2**	**1**	**2**	**1**	**3**
CO5	For a given 8085 microprocessor, student would be able to understand and analyze its architecture, Interfacing devices, Instruction set and programming.	**1**	**1**	**3**		**1**		

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

NPTEL, UDEMY and Coursera

13. Books recommended:

1. Electronic Device and Circuit: R. Boylested and L. Nashdsky
2. Analysis and Design of Digital Integrated Circuit: Hodges, Jackson and Saleh
3. Digital Principles and Implementation: A.P. Malvino and D.P. Leach
4. Op- Amp and Linear Integrated Circuit: Ramakant A. Gayakwad

1.Name of the Department: Physics						
2.Course Name	**Programming and Condensed Matter Physics lab**			**L**	**T**	**P**
3.Course Code	**PY412**			0	0	9
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5.Pre-requisite (if any)	BSc with Physics and Mathematics	**6. Frequency (use tick marks)**	Even **(√)**	Odd **( )**	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 00	**Tutorials = 00**	**Practical = 10**

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart practical measurements using numerical techniques in condensed matter physics.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To determine solution of transcendental/polynomial equations and perform matrix operations using MATLAB.
CO2	To determine numerical solution of differential equations and perform integration of given functions.
CO3	To study the characteristics of a Geiger–Müller (GM) counter and demonstrate its utilization.
CO4	To analyze and evaluate magnetic, dielectric and transport properties of materials/semiconductors.

10.Syllabus

Exp-01	Solution of transcendental or polynomial equations by the Newton Raphson method.
Exp-02	Linear curve fitting and calculation of linear correlation coefficient using MATLAB.
Exp-03	Numerical integration using the Simpson's method.
Exp-04	Numerical first order differentiation of a given function.
Exp-05	Matrix inversion and solution of simultaneous equation.
Exp-06	To determine resolving/dead time of a GM counter by double source method.
Exp-07	Study of Hall Voltage as a function of probe current and magnetic field and determination of Hall Coefficient and carrier concentration in given sample.
Exp-08	Preparation of nano-crystalline powder specimen by ball milling: analysis of their x-ray spectra and particle size estimation by Scherrer formula.
Exp-09	Magnetic parameters of a magnetic material by hysteresis loop tracer.
Exp-10	Dielectric constant of insulating and ferroelectric materials at room and elevated temperatures.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	To determine solution of transcendental/polynomial equations and perform matrix operations using MATLAB.	**2**	**2**	**3**		**1**	**1**	**2**
CO2	To determine numerical solution of differential equations and perform integration of given functions.	**3**	**3**	**1**		**2**	**3**	**3**
CO3	To study the characteristics of a Geiger–Müller (GM) counter and demonstrate its utilization.	**2**	**2**	**2**		**1**	**1**	**2**
CO4	To analyze and evaluate magnetic, dielectric and transport properties of materials/semiconductors.	**3**	**2**	**1**		**2**	**2**	**3**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

1. http://www.rossnazirullah.com/BSc/BSc.htm
2. www.youtube.com
3. https://old.iitbhu.ac.in/institute-repository/db/2018/ir-2018-125/gmcounter.pdf
4. http://experimentationlab.berkeley.edu/sites/default/files/writeups/SHE.pdf

13. Books recommended:

1. The normal Hall effect by Richard A Dunlap, Morgan and Claypool Publishers.
2. Nano Materials by B. Viswanathan, Narosa.
3. Introduction to Solid State Physics by C. Kittel, Wiley.
4. Practical physics by Kumar P.R.S., PHI learning private limited

SYLLABI
SEMESTER – III

1.Name of the Department: Physics						
2.Course Name	**Atomic and Molecular Physics**			**L**	**T**	**P**
3.Course Code	**PY501**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even **()**	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = 00**

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart advance knowledge of atomic and molecular physics to obtain quantitative and qualitative analysis in the field of spectroscopy for higher studies. After successfully completion of course, the student will be able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	To obtain the quantum mechanical solution of hydrogen and hydrogen-like atoms and analyze the spectra of alkali atoms.
CO2	To obtain the quantum mechanical solution of many-electron under different approximations thereby evaluate spectroscopic terms under LS and JJ coupling schemes.
CO3	Evaluate and analyse the Pure- Rotational spectra, Rotational-vibrational spectra and electronic spectra of diatomic molecules.
CO4	To investigate the energy spectrum of mono, dia or poly-atomic molecules using different spectroscopic technique.
CO5	To understand and contrast the working of different spectroscopes.

10.Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Atomic Physics-I**

Quantum Mechanical Treatment of one-electron Atom, Spin-Orbit interaction and fine structure of hydrogen atom, Spectra of alkali elements. Singlet and triplet States of Helium.

Unit-2	**Number of lectures = 08**	**Title of the unit: Atomic Physics-II**

Many electron atoms: Central field approximation, Thomas-Fermi field, Atomic wave function, Hartree and Hartree–Fock approximations, Spectroscopic Terms: L S and J J coupling schemes for many electron atoms, wave functions and energies of multiplets, Electric dipole and Electric Quadrupole.

Unit-3	**Number of lectures = 08**	**Title of the unit: Molecular Physics**

Born-Oppenheimer approximation, Heitler-London theory of H_2, LACO treatment of H_2^+ and H_2. Classification of Molecules, Types of Molecular Spectra and Molecular Energy States: Pure Rotational Spectra, Vibrational-Rotational Spectra, Raman Scattering, Selection rules, Nuclear spin and intensity alternation, Isotope effect, Classification of electronic states, Coupling of rotational and electronic motions, Electronic spectra: Franck-Condon principle.

Unit-4	**Number of lectures = 08**	**Title of the unit: Spectroscopy**

Infrared Spectroscopy, Raman spectroscopy, Photoelectron Spectroscopy, Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance (Introduction and their principles only).

Unit-5	**Number of lectures = 08**	**Title of the unit: Spectroscopic Techniques**

General description and working of infra-red Spectrophotometer, Photoelectron Spectrometer, Simple Raman Spectrometer, NMR Spectrometer and ESR Spectrometer.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	To obtain the quantum mechanical solution of hydrogen and hydrogen-like atoms and analyze the spectra of alkali atoms.	**3**	**1**	**2**		**2**	**3**	**1**
CO2	To obtain the quantum mechanical solution of many-electron under different approximations thereby evaluate spectroscopic terms under LS and JJ coupling schemes..	**2**	**2**	**1**		**1**	**1**	**3**
CO3	Evaluate and analyse the Pure- Rotational spectra, Rotational-vibrational spectra and electronic spectra of diatomic molecules.	**3**	**1**	**2**		**3**	**2**	**1**
CO4	To investigate the energy spectrum of mono, dia or poly-atomic molecules using different spectroscopic	**2**	**2**	**1**		**2**	**1**	**1**
CO5	To understand and contrast the working of different spectroscopes.	**3**	**1**	**2**		**3**	**1**	**3**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115101003/
2. https://nptel.ac.in/courses/115105100/
3. https://www.freebookcentre.net/physics-books-download/Atomic-and-Molecular-Physics-NPTEL.html

13. Books recommended:

1. Introduction to atomic spectra by H.E. White
2. Spectra of diatomic molecules by Herzberg
3. Atoms and molecules by M. Weissbluth
4. Quantum theory of Atomic Structure Vol I by Slater
5. Quantum theory of molecules and Solids by Slater
6. Fundamentals of molecular spectroscopy by C. B. Banwell
7. Introduction to molecular spectroscopy by G. M. Barrow
8. Molecular spectroscopy by Jeanne L. McHale
9. Molecular spectroscopy by J. M. Brown
10. Spectra of atoms and molecules by P.F. Bemath
11. Modern spectroscopy by J.M. Holias

1.Name of the Department: Physics						
2.Course Name	**Electronic Instrumentation**			**L**	**T**	**P**
3.Course Code	**PY502**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Basics of Electronics and measurement	**6.Frequency (use tick marks)**	Even **( )**	Odd (√)	Either Sem ( )	Every Sem ( )
7.Total Number of Lectures, Tutorials, Practicals						
Lectures=30		**Tutorials=10**	**Practical=00**			

8. COURSE OBJECTIVES:

1. Build the student strong background in the field of instrumentation and measurement.
2. To understand the basic concept of different types of filters and concepts of electronics communication.
3. To learn the basic concept of telemetry system, wave analyzer and CRO

9. COURSE OUTCOMES (CO): ***After the successful course completion, learners will develop following attributes:***

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Recognize the evolution and history of units and standards in Measurements.
CO2	Identify the various parameters that are measurable in electronic instrumentation.
CO3	Employ appropriate instruments to measure given sets of parameters.
CO4	Practice the construction of testing and measuring set up for electronic systems
CO5	To have a deep understanding about instrumentation concepts which can be applied to Control systems.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Signal representation & generation

Periodic signals, modulated signals (A.M.F.M.P.M.), sampled data pulse Modulation PWM, PAM, PPM) definition and their graphical representation. Generation of sine, Square, triangular, linear ramp & saw tooth waveform.

Unit-2	Number of lectures = 08	Title of the unit: Measurement of electrical signals

Meters: comparison of analog & digital meters, moving coil, moving iron, electrodynamics, Induction meter, clamp on meter. CRO: Block diagram of general purpose CRO, Detail study of CRT, Dual beam oscilloscope, How CRO displays waveform, various methods of measurement of voltage, current, resistance, frequency, phase, capacitance & inductance.

Unit-3	Number of lectures = 08	Title of the unit: Signal Processing Circuit

Electronic amplifiers: Difference or balance amplifier, Operational amplifier, Instrumentation amplifier, Charge amplifier, Power amplifier. passive & active filters. Butter worth filter (low pass, High pass, band pass), Notch filter.

Unit-4	Number of lectures = 08	Title of the unit: Data Acquisition conversion, processing & transmission system

General DAS, signal conditioning of inputs, single channel DAS multichannel DAS,R-2R ladder Network, successive approximation type ADC, Analog & digital multiplexer, Sample and hold Circuit. Data transmission system. Telemetry system Block diagram, Characteristics, Land line Telemetry, Radio telemetry, Processing system.

Unit-5	Number of lectures = 08	Title of the unit: Applications of Electronic System

Frequency selective wave analyzer, Spectrum analyzer, Lock-in amplifier, Fiber optic sensors. Measurement of Humidity, Hygrometers, Measurement of pH, Measurement of thermal Conductivity (gas analyzer), Nuclear instrumentation-types of radiation, Geiger-muller tube, ionization chamber. Flow meters: Classification, working principle, electromagnetic flow meter, Ultrasonic flow meter. Q Meter- principle, working & applications. DFM-Block diagram, principle & working. DMM Block diagram, principle & working.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Recognize the evolution and history of units and standards in Measurements.	**3**	**2**	**2**	**1**	**2**	**1**	
CO2	Identify the various parameters that are measurable in electronic instrumentation.	**2**	**3**	**2**	**2**	**1**	**2**	**1**
CO3	Employ appropriate instruments to measure given sets of parameters.	**3**	**2**	**1**	**2**	**2**	**1**	
CO4	Practice the construction of testing and measuring set up for electronic systems	**3**	**1**	**3**	**1**	**1**		**2**
CO5	To have a deep understanding about instrumentation concepts which can be applied to Control systems.	**1**	**3**	**1**	**3**			**3**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://ocw.tudelft.nl/courses/electronic-instrumentation/
3. https://www.classcentral.com/course/swayam-electrical-measurement-and-electronic-instruments-14032
4. https://swayam.gov.in/nd1_noc19_ee44/preview

13. Books recommended:

1. Transducers& Instrumentation: D. V. S. Murthy.
2. Instrumentation-Devices &system: C. S. Rangan,G. R. Sharma, V. S. V. Mani.
3. Principles of measurement and Instrumentation: Alan S. Morris.
4. Electronic Instrumentation: Kalsi.
5. Electrical & electronic measurement Instrumentation: A. K. Sawhney.
6. Modern electronic instrumentation & measurement Technique: Helfrick Coope

1.Name of the Department: Physics						
2.Course Name	**Advanced Condensed Matter Physics**			**L**	**T**	**P**
3.Course Code	**PY503**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: The purpose of this course is to impart advance knowledge of condensed matters. With the help of various physics and mathematics laws the student will study a detailed study of various important phenomena of physics in condensed matter. After completion of the course, the student will be able to explore the subject in the field of research.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of the various phenomena of dielectrics and ferroelectrics.
CO2	Students will learn about the Optical properties of materials.
CO3	The students will gain the knowledge about the various physics laws of magnetism and their quantum mechanical formulation.
CO4	The students will learn about the superconducting behaviour and its interpretation in materials.
CO5	Students will analyse and understand various types of defects in solids.

10.Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Dielectrics and Ferroelectrics**

Macroscopic electric fields, local field at an atom, dielectric constant and polarizability, ferroelectricity, antiferroelectricity, phase transition, piezoelectricity, ferroelasticity, electrostriction.

Unit-2	**Number of lectures = 08**	**Title of the unit: Optical Properties of Materials**

Optical constants, Kramers - Kroning relations, polarons, excitons. Electronic interband and intraband transitions, relation between optical properties and band structure, reflectance, diffraction, dispersion, photoluminescence, electroluminescence, screening, plasmons.

Unit-3	**Number of lectures = 08**	**Title of the unit: Magnetism**

Diamagnetism (including Landau diamagnetism) and Paramagnetism (including Van Vleck and Langevin paramagnetism), Exchange interaction of free electrons, Ferromagnetism, super exchange, double exchange, Antiferromagnetism, Neel temperature, spin-waves, Bloch wall, Bloch-$T^{3/2}$ Law, anisotropy energy, Landau levels, Degeneracy

Unit-4	**Number of lectures = 08**	**Title of the unit: Superconductivity**

Fundamental phenomena of superconductivity, Meissner effect, London equation, Type I and type II superconductors. Ginsburg-Landau Theory, Coopers pairing and BCS theory. BCS wave-functions, Josephson Effect, SQUIDS. Weakly interacting Bose gas, Superfluidity.

Unit-5	**Number of lectures = 08**	**Title of the unit: Atomic Imperfections in Solids**

Point imperfection in ionic crystals, Line imperfection, Edge and Screw dislocation, Burgers vector and Burger's circuit, Dislocation motion, Energy of dislocation, Slip planes and slip directions, Perfect and imperfect dislocations, Dislocation reaction, Surface imperfections, Grain boundary, Tilt and Twist boundary.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of the various phenomena of dielectrics and ferroelectrics.	**3**	**2**	**1**		**2**	**3**	**3**
CO2	Students will learn about the Optical properties of materials.	**2**	**3**	**2**		**3**	**1**	
CO3	The students will gain the knowledge about the various physics laws of magnetism and their quantum mechanical formulation.	**2**	**1**	**3**		**3**	**2**	**1**
CO4	The students will learn about the superconducting behaviour and its interpretation in materials.	**3**	**2**	**1**		**1**	**1**	
CO5	Students will analyse and understand various types of defects in solids.	**2**	**1**	**2**		**2**	**2**	**2**

3: Strong contribution, 2: Average contribution , 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/103/115103102/
2. https://nptel.ac.in/courses/115/106/115106061/
3. https://nptel.ac.in/courses/115/101/115101009/

13. Books recommended:

1. N.W. Ashcroft and N.D. Mermin, *Solid State Physics.*
2. D. Pines, *Elementary Excitations in Solids.*
3. S. Raimes, *The Wave Mechanics of Electrons in Metals.*
4. P. Fazekas, *Lecture Notes on Electron Correlation and Magnetism.*
5. M. Tinkham, *Introduction to Superconductivity.*
6. M. Marder, *Condensed Matter Physics.*

1. Name of the Department: Physics						
2. Course Name	**Communication Electronics**			**L**	**T**	**P**
3. Course Code	**PY504**			3	1	0
4. Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5. Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6. Frequency (use tick marks)**	Even ()	Odd (√)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge of communication through electronics system. Knowledge of fundamental concepts and principles to solve the communication electronics problem.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students shall be able to understand about the functions of various microwave devices and its operation.
CO2	For the Amplitude modulated systems, student shall be able to understand the various types of modulation and its evaluation with applications.
CO3	Student shall be able to understand the basics of angle modulation in analog communication system and analysis of Parameter variation, FM and PM generation and reception.
CO4	Students shall be able to understand of the Transmission and Radiation of signals. They are able to calculate impedance, Smith Chart, standing wave ratio and measurements at radio frequencies
CO5	Student shall be able understand the sources of optical communication, optical receivers and optical fiber, Students are able to define S/N and effect of noise in the optical communication system.

10. Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Microwave Devices

Klystrons amplifiers, velocity modulation, Basic principles of two cavity klystrons, Multicavity klystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and Travelling wave tube (TWT). Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.

Unit-2	Number of lectures =08	Title of the unit: Amplitude Modulated Systems

Frequency translation, method of frequency translation, recovery of the base band signal, Amplitude modulation, Maximum allowed modulation, The square law demodulation, Spectrum of an amplitude modulated signal, Modulators and Balanced modulators, Single side band modulation, Methods of generating as SSB signal, Vestigial side band modulation, Multiplexing.

Unit-3	Number of lectures = 08	Title of the unit: Frequency Modulated Systems

Angle modulation, Phase and frequency modulation, Relationship between phase and frequency modulation, Phase and frequency deviation, Spectrumof an FM signal, Sinusoidal modulation, Bandwidth of a sinusoidally modulated FM signal, FM generation, Parameter variation method, Armstrong system.

Unit-4	Number of lectures = 08	Title of the unit: Transmission and Radiation of Signals

Primary line constants, phase velocity and line wavelength, Characteristic impedance, Propagation Coefficient, Phase and group velocities, Standing waves, Lossless line at radio frequencies, Voltage standing wave ratio, Slotted line measurements at radio frequencies, Transmission lines as circuit elements, Smith chart, Single and double Stub matching, Time domain reflectometry, Telephone lines and cables, Radio frequency lines.

Unit-5	Number of lectures = 08	Title of the unit: Fiber Optic Communication

Light sources for optical communication, Optical Receivers, Modes in Optical fiber, Optical communication system, Losses in fibers, Dispersion in fiber, Power Budgeting, S/N ratio, Effect of index profile on propagation, TDM, WDM.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students shall be able to understand about the Microwave devices and its operation.	**2**	**1**	**2**		**2**	**3**	
CO2	For the Amplitude Modulated Systems, student shall be able to understand the various types of modulation in the signal. Able to apply this knowledge in the lab.	**3**	**2**	**3**	**1**	**1**	**1**	**1**
CO3	Student shall be able to understand the basics of angle Modulated in analog communication system and analysis of Parameter variations. FM & PM generation and reception.	**1**	**3**	**2**	**1**	**2**	**3**	**2**
CO4	Students shall be able to understand of the Transmission and Radiation of signals. They are able to calculate impedance, Smith Chart, standing wave ratio and measurements at radio frequencies.	**2**	**2**	**1**		**1**	**2**	**1**
CO5	Student shall be able understand the sources of optical communication, Optical Receivers and Optical fiber, Students are able to define S/N and effect of noise in the optical communication system.	**3**	**1**	**2**	**1**	**2**	**1**	

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

NPTEL, Udemy, Coursera etc.

13. Books recommended:

1. Electronic Devices and circuit Theory by R. Boylested and L. Nashelsky
2. Principles of Communication Systems by H. Taub and Donald L. Schilling
3. Optoelectronics: Theory and Practice, Edited by Alien Chappal
4. Microwaves by K.L. Gupta
5. Electronic communications by Dennis Roddy and John Coolen

1.Name of the Department: Physics						
2.Course Name	**Numerical Techniques and Statistical Mechanics-II**			**L**	**T**	**P**
3.Course Code	**PY505**			3	1	0
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ()**		**Departmental Elective ()**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even ( )	Odd (√)	Either Sem ( )	Every Sem ( )

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	**Tutorials = 10**	**Practical = Nil**

8. COURSE OBJECTIVES: The purpose of this postgraduate course is (1) to impart the knowledge of different mathematical tools required for the rigorous analysis of data and its interpretation (2) Advance concepts of physics of phase transitions. By using the principles of physics and mathematics, students will be able to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will be able explore subject into their respective dimensions.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to analyze, interpret, perform error analysis and testing of data using different types of mathematical tools.
CO2	Students will be able to apply various types of numerical techniques to solve different mathematical problems.
CO3	Students will gain an understanding about the phase transition phenomenon and different theoretical explanation behind it.
CO4	Students will develop their understanding about the dynamical models of phase transitions.
CO5	Students will gain an understanding about the fluctuations in physical parameter when the system is slightly out of equilibrium and to apply advance mathematical tools to deal with such type of problems.

10.Unit wise detailed content

Unit-1	**Number of lectures = 08**	**Title of the unit: Numerical Analysis**

Data interpretation and analysis, Precision and accuracy, Error analysis, propagation of errors, least square fitting, linear and nonlinear curve fitting, goodness of fit, chi-square test.

Unit-2	**Number of lectures = 08**	**Title of the unit: Statistical Techniques**

Elements of computation techniques; root of functions, interpolation, extrapolation, Newton's forward and backward interpolation, Lagrange's interpolation formula, integration by trapezoidal and Simpson's rules, Solution of first order differential equation using Runge-Kutta method, Finite difference method, Lagrange's method of undetermined multipliers.

Unit-3	**Number of lectures = 08**	**Title of the unit: Phase Transitions and Critical Phenomena**

Coexistence of phases, Gibb's phase rule, classification of phase transitions, critical phenomena and critical exponents, Landau theory, scaling hypothesis, universality classes phase transition of Vander Waal's gas, phase transition in liquid He, second, third and fourth sounds, Tisza two fluid model, Landau's spectrum of phonons and rotons.

Unit-4	**Number of lectures = 08**	**Title of the unit: Dynamical Models of Phase Transitions**

Heisenberg model, mean-field theory, Ising model in 1D, exact solution in one dimension, renormalization in one dimension, order disorder transformation in alloys, structural phase change, lattice gas.

Unit-5	**Number of lectures = 08**	**Title of the unit: Non-equilibrium Systems and Time Correlation Functions**

Systems out of equilibrium, approach to equilibrium and the H-theorem, thermodynamics of fluctuations, fluctuation-dissipation theorem, Fokker-Planck equation, Onsager relations, statistical correlation, correlation length, spatial and spin-spin correlation.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to analyze, interpret, perform error analysis and testing of data using different types of mathematical tools.	**3**	**1**	**1**	**2**	**2**	**1**	**3**
CO2	Students will be able to apply various types of numerical techniques to solve different mathematical problems.	**2**	**3**	**1**		**3**	**2**	**2**
CO3	Students will gain an understanding about the phase transition phenomenon and different theoretical explanation behind it.	**3**	**1**	**2**		**3**	**1**	**3**
CO4	Students will develop their understanding about the dynamical models of phase transitions.	**1**	**2**	**3**	**1**	**2**	**2**	**2**
CO5	Students will gain an understanding about the fluctuations in physical parameter when the system is slightly out of equilibrium and to apply advance mathematical tools to deal with such type of problems.	**3**	**1**	**2**	**1**	**2**	**3**	**1**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/115/106/115106091/
2. https://nptel.ac.in/courses/115/103/115103028/
3. http://www.math.wisc.edu/~shottovy/NumPDEreport.pdf
4. https://www.damtp.cam.ac.uk/user/tong/statphys/five.pdf

13. Books recommended:

1. K. Huang, *Statistical Mechanics.*
2. R.K. Pathria, *Statistical Mechanics.*
3. E.M. Lifshitz and L.P. Pitaevskii, *Physical Kinetics.*
4. D.A. McQuarrie, *Statistical Mechanics.*
5. L.P. Kadanoff, *Statistical Physics: Statistics, Dynamics and Renormalization.*
6. P.M. Chaikin and T.C. Lubensky, *Principles of Condensed Matter Physics.*

1.Name of the Department: Physics						
2.Course Name	**Electronics Lab**			**L**	**T**	**P**
3.Course Code	**PY506**			0	0	9
4.Type of Course (use tick mark)		**Core (√)**	**Foundation Course ( )**		**Departmental Elective ( )**	
5.Pre-requisite (if any)	BSc with Physics and Mathematics and Electronics	**6. Frequency (use tick marks)**	Even **(√)**	Odd **( )**	Either Sem ( )	Every Sem ( )

7. Total Number of Lectures, Tutorials, Practicals

Lectures = 00	**Tutorials = 00**	**Practical = 10**

8. COURSE OBJECTIVES:

- To realize the combinational circuit.
- To know the concepts of ALU
- To design up-down counter with the different Flip Flop
- To understand the concepts of Microprocessor 8085/8086

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students shall be able to Learn, understand, design and verify the truth tables of combinational circuit.
CO2	Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools.
CO3	Students shall be able to Learn, understand, design and verify the truth tables of Sequential circuit.
CO4	Students shall be able to Learn and understand the concepts of memory cell.
CO5	Students shall be able to write the Assembly language programming and shall be able to execute the program using 8085 kit.

10.Syllabus

Exp-01	Temperature to frequency conversion using a thermister and astable multivibrator circuit.
Exp-02	Operational Amplifier characteristics using IC 741.
Exp-03	Capacitance measurement using IC 555.
Exp-04	Experiments on MUX, DEMUX, Decoder and shift register.
Exp-05	JK Flip-Flop and up-down counter.
Exp-06	Fiber optic communication.
Exp-07	A/D converter interfacing and AC/DC voltage / current measurement using microprocessor 8085/8086.
Exp-08	PPI 8251 interfacing with microprocessor for serial communication.
Exp-09	D/A converter interfacing and frequency / temperature measurement with microprocessor 8085 / 8086.
Exp-10	Program of 8085/ 8086 to solve a Boolean Equation which rep. Combinational logic.
Exp-11	Arithmetic operations using microprocessors 8085 / 8086.

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students shall be able to Learn, understand, design and verify the truth tables of combinational circuit.	**3**	**3**	**3**	**3**		**2**	**1**
CO2	Prepare professional quality textual and computational results, incorporating accepted data analysis and synthesis methods, simulation software, and word-processing tools.	**2**	**2**	**1**	**1**			**2**
CO3	Students shall be able to Learn, understand, design and verify the truth tables of Sequential circuit.	**3**	**1**	**3**	**3**		**2**	**2**
CO4	Students shall be able to Learn and understand the concepts of memory cell.	**1**	**3**	**3**	**1**			**3**
CO5	Students shall be able to write the Assembly language programming and shall be able to execute the program using 8085 kit.	**3**	**2**	**2**	**2**		**3**	

3: Strong contribution, 2: Average contribution, 1: Low contribution

12. Brief description of self learning / E-learning component

1. https://nptel.ac.in/courses/108/105/108105153/
2. https://ocw.tudelft.nl/courses/electronic-instrumentation/
3. https://www.classcentral.com/course/swayam-electrical-measurement-and-electronic-instruments-14032
4. https://swayam.gov.in/nd1_noc19_ee44/preview

13. Books recommended:

1. Electronic Devices and circuit Theory by R. Boylested and L. Nashelsky
2. Principles of Communication Systems by H. Taub and Donald L. Schilling
3. Electronic communications by Dennis Roddy and John Coolen
4. Optoelectronics: Theory and Practice, Edited by Alien Chappal

SYLLABI
SEMESTER – IV

1.Name of the Department: Physics						
2.Course Name	**Physics of Nanomaterials**			**L**	**T**	**P**
3.Course Code	**PY509**			3	1	0
4.Type of Course (use tick mark)		**Core ()**	**Foundation Course ( )**		**Departmental Elective (√)**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem ( )

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this postgraduate course is to impart basic and key knowledge of Nanoscience and Nanomaterials. By using the principles of physics and mathematics, student will be able to obtain quantitative relations which are very important for higher studies. After successful completion of course, the student will be able explore subject into their respective dimensions

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of how the different manifestation of modern science and their interdisciplinary nature leads to a new technology which is applicable in various walks of life.
CO2	Students will be able to realize the importance of concepts of advance physics behind the development of a new theory.
CO3	Students will gain an understanding of new concepts of quantum confinement and evaluate its role in formation of quantum structures.
CO4	Students will learn about the different characterization techniques required for the properties estimation of materials at nanoscale.
CO5	Students will Realize the key issues in the synthesis of nanomaterials and the different approaches used for their synthesis.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction to Nanostructure Materials

Nanoscience and nanotechnology, Size dependence of properties, Moore's law, Surface energy and Melting point (quasi melting) of nanoparticles.

Unit-2	Number of lectures = 08	Title of the unit: Band Structure of Solids

Free electron theory (qualitative idea) and its features, Idea of band structure, insulators, semiconductors and conductors, Energy band gaps of semiconductors, Effective masses and Fermi surfaces, Localized particles, Donors, Acceptors and Deep traps, Mobility, Excitons, Density of states, Variation of density of states with energy and Size of crystal.

Unit-3	Number of lectures = 08	Title of the unit: Quantum Size Effect

Quantum confinement, Nanomaterials structures, Two-dimensional quantum system, Quantum well, Quantum wire and Quantum dot, Fabrication techniques.

Unit-4	Number of lectures = 08	Title of the unit: Characterization Techniques of Nanomaterials

Determination of particle size, XRD (Scherrer's formula), Increase in width of XRD peaks of nanoparticles, Shift in absorption spectra peak of nanoparticles, Shift in photoluminescence peaks, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Scanning Tunneling Electron Microscopy (STEM), and Atomic Force Microscopy (AFM).

Unit-5	Number of lectures = 08	Title of the unit: Synthesis of Nanomaterials

Key issue in the synthesis of Nanomaterials, Different approaches of synthesis, Top down and Bottom-up approaches, Cluster beam evaporation, Ball Milling, Chemical bath deposition with capping agent, Carbon nanotubes (CNT)-Synthesis, Properties and Applications.

11. CO-PO Mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of how the different manifestation of modern science and their interdisciplinary leads to a new technology which is applicable in various walks of life.	**3**	**1**	**1**	**2**	**2**	**3**	**2**
CO2	Students will be able to realize the importance of concepts of advance physics behind the development of a new theory.	**1**	**2**	**2**		**2**	**1**	**3**
CO3	Students will gain an understanding of new concepts of quantum confinement and evaluate its role in formation of quantum structures.	**3**	**1**	**3**		**3**	**1**	**1**
CO4	Students will learn about the different characterization techniques required for the properties estimation of materials at nanoscale.	**2**	**3**	**1**		**2**	**2**	**3**
CO5	Students will realize the key issues in the synthesis of nanomaterials and the different approaches used for their synthesis.	**3**	**1**	**2**	**1**	**3**	**1**	**3**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/118/104/118104008/
2. https://nptel.ac.in/courses/118/102/118102003/
3. https://www.nanowerk.com/nanotechnology/introduction/introduction_to_nanotechnology_1.php

13. Books recommended:

1. Nanostructures and Nanomaterials, Synthesis, Properties and Applications by Guozhong Cao, Imperial College Press.
2. Introduction to Nanotechnology, by Charles P. Poole, Jr. Frank J. Owens, John Wiley and Sons Inc. Publication.
3. Quantum Wells, Wires and Dots by Paul Harrison, John Wiley and Sons Ltd.
4. Quantum Dot Hetrostructures, by D. Bimberg, M. Grundman, N.N. Ledenstov.
5. Introduction to Nanoscience and Nanotechnology by Hornyak G.L., Tibbals H.F., Dutta J., Moore J.J., CRC Press.
6. Carbon Nanotechnology by Liming Dai
7. Carbon Nanotubes: Properties and Applications by Michael J. O'. Connell

1.Name of the Department: Physics						
2.Course Name	**Laser Physics**			**L**	**T**	**P**
3.Course Code	**PY512**			3	1	0
4.Type of Course (use tick mark)		**Core()**	**Foundation Course ( )**		**Departmental Elective(√)**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ( )	Every Sem( )

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES: The purpose of this course is to impart basic and key knowledge of lasers. With the use of various principles of Physics and Mathematics a deep understanding of laser rate equations will be explained to the students. The course will provide a detailed knowledge of various phenomena involved in the construction of lasers and their applications.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will gain an understanding of the basic principle, construction and functioning of a variety of lasers.
CO2	Students will be able to understand and solve the laser rate equations of two, three and four level lasers.
CO3	Students will be able to understand the functioning of various types of cavities involved in the construction of lasers stability, quality factor.
CO4	Students will gain an understanding of Coherence and Pulsed Operation and statistics of Lasers.
CO5	Students will learn about the various applications of lasers.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Introduction

Masers versus lasers, components of a laser system, amplification by population inversion, oscillation condition, types of lasers: solid-state (Ruby, Nd: YAG, semiconductor), gas (He- Ne, $CO_2$and Excimer), liquid (organic dye) lasers.

Unit-2	Number of lectures = 08	Title of the unit: Atom-Field Interactions

Lorentz theory, Einstein's rate equations, applications to laser transitions with pumping, two, three and four-level schemes, threshold pumping and inversion.

Unit-3	Number of lectures = 08	Title of the unit: Optical Resonators

Closed versus open cavities, modes of a symmetric confocal optical resonator, stability, quality factor.

Unit-4	Number of lectures = 08	Title of the unit: Coherence and Pulsed Operation of Lasers

Concepts of coherence and correlation functions, coherent states of the electromagnetic field, minimum uncertainty states, unit degree of coherence, Poisson photon statistics. Q- switching, electro-optic and acousto-optic modulation, saturable absorbers, mode- locking.

Unit-5	Number of lectures = 08	Title of the unit: Applications of Lasers

Introduction to atom optics, Doppler cooling of atoms, introduction to nonlinear optics: self-(de) focusing, second-harmonic generation (phase-matching conditions).

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will gain an understanding of the basic principle, construction and functioning of a variety of lasers.	**3**	**1**	**1**	**1**		**2**	**1**
CO2	Students will be able to understand and solve the laser rate equations of two, three and four level lasers.	**2**	**3**			**3**	**3**	
CO3	Students will be able to understand the functioning of various types of cavities involved in the construction of lasers stability, quality factor.	**3**	**1**	**3**	**1**	**1**	**1**	**2**
CO4	Students will gain an understanding of Coherence and Pulsed Operation and statistics of Lasers.	**1**	**1**	**1**		**2**	**2**	
CO5	Students will learn about the various applications of lasers.	**2**	**3**	**3**	**1**	**2**	**2**	**1**

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. https://nptel.ac.in/courses/104/104/104104085/
2. https://nptel.ac.in/courses/115/105/115105105/
3. https://nptel.ac.in/courses/115/105/115105104/

13. Books recommended:

1. K. Thyagarajan and A.K. Ghatak, *Lasers: Theory and Applications.*
2. A.K. Ghatak and K. Thyagarajan, *Optical Electronics.*
3. W. Demtroeder, *Laser Spectroscopy.*
4. B.B. Laud, *Lasers and Nonlinear Optics.*
5. M. Sargent III, M.O. Scully and W.E. Lamb, Jr., *Laser Physics.*
6. M.O. Scully and M.S. Zubairy, *Quantum Optics.*
7. P. Meystre and M. Sargent III, *Elements of Quantum Optics.*
8. L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics.*

1.Name of the Department: Physics						
2.Course Name	**Renewable Energy Resources**			**L**	**T**	**P**
3.Course Code	**PY514**			3	1	0
4.Type of Course (use tick mark)		**Core ()**	**Foundation Course ()**		**Departmental Elective (√)**	
5.Pre-requisite (if any)	B.Sc. with Physics and Mathematics	**6.Frequency (use tick marks)**	Even (√)	Odd ()	Either Sem ()	Every Sem ()

7.Total Number of Lectures, Tutorials, Practicals

Lectures = 30	Tutorials = 10	Practical = Nil

8. COURSE OBJECTIVES:

- ❖ To understand the principle, origin conversion process, origin, advantages, disadvantages and limitation of Solar, Biomass, wind, Ocean, tidal, Geothermal Energy.
- ❖ To understand emerging trends of Renewable Energy sources (Fuel Cell, Hydrogen Cell and MHD Energy)
- ❖ To understand the analysis of Solar PV System, digester and windmill.
- ❖ To understand the concept of geothermal electric power plant.

9. COURSE OUTCOMES (CO):

After the successful course completion, learners will develop following attributes:

COURSE OUTCOME (CO)	ATTRIBUTES
CO1	Students will be able to explain renewable and renewable energy resources, solar cell, PV System and Photovoltaic concept. Also able to explain limitation and application of PV system.
CO2	Students will be able to explain biomass energy, biomass energy conversion process, fixed and continuous type digester and liquefaction and gasification process of biomass.
CO3	Students will be able to explain wind energy as a type of renewable energy, its origin and power in wind, principle of wind mill, Ocean energy and tidal energy.
CO4	Students will be able to explain geothermal energy and its resources, dry steam, wet steam & hot water geothermal system and geothermal power plant and thermal power plant.
CO5	Students will be able to answer the principle, operation classification, performance characteristic and types of fuel cell and also hydrogen as fuel, conversion to energy and Applications.

10.Unit wise detailed content

Unit-1	Number of lectures = 08	Title of the unit: Solar Energy

Solar Energy conversion systems and their applications, Fundamentals of photovoltaic energy conversion, Principles of photo voltaic cell, Materials and fabrication technologies of P.V cell, P. V. Systems: configuration, output power and conversion efficiency, Basic P.V. system for power generation, Applications and limitations of P.V. systems.

Unit-2	Number of lectures = 08	Title of the unit: Biomass Energy Conversion Technologies

Origin of biomass, Biomass energy resources, Biomass energy conversion processes, generation of gaseous fuels from biomass, digesters and their designs, Energy from Cereals, grains, sugar, fruits, starch etc.

Unit-3	Number of lectures = 08	Title of the unit: Wind Energy & Ocean Energy

Introduction to wind energy, Nature & Origin of winds, Power in a wind stream, principles and basic components of wind mill, Efficiency of wind turbine, horizontal and vertical axis wind mills, performance of wind mills, merits and limitations of wind energy conversions. Ocean as the potential energy resource: various ocean energy conversion technologies, Introduction to OTEC, Principle of OTEC, Ocean waves, energy and power from ocean waves, origin of tidal energy, Tidal energy conversion, tidal energy conversion schemes.

Unit-4	Number of lectures = 08	Title of the unit: Geothermal Energy

Geothermal energy as a renewable source of energy, Types of geothermal resources, Origin of geothermal resources, Hydro geothermal, Geo pressure geothermal and Petro geothermal resources, Basics of geothermal electric power plant.

Unit-5	Number of lectures = 08	Title of the unit: Emerging trends in Renewable Energy sources

Fuel Cells: Principle and operation of fuel cell, classification and types of fuel cells, Phosphoric acid fuel cell (PAFC), Alkaline fuel cell (AFC), Molton carbonate fuel cell (MCFC), Solid oxide fuel cell (SOFC), Fuels for fuel cells, Performance characteristics of fuel cells, Practical fuel cell power plant. Hydrogen Energy: Hydrogen as clean source of energy, sources Production, storage, Use of hydrogen as fuel, conversion to energy, Applications. Magneto hydrodynamics Energy: MHD generator, Basic principle,(H-12 M-20)

11. CO-PO mapping

COs	Attributes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Students will be able to explain renewable and renewable energy resources, solar cell, PV System and Photovoltaic concept. Also able to explain limitation and application of PV system.	2	2	3	1	1	2	3
CO2	Students will be able to explain biomass energy, biomass energy conversion process, fixed and continuous type digester and liquefaction and gasification process of biomass.	3	1	2	1	1	3	1
CO3	Students will be able to explain wind energy as a type of renewable energy, its origin and power in wind, principle of wind mill, Ocean energy and tidal energy.	2	3	1			1	2
CO4	Students will be able to explain geothermal energy and its resources, dry steam, wet steam & hot water geothermal system and geothermal power plant and thermal power plant.	3	2	1	1		2	1
CO5	Students will be able to answer the principle, operation classification, performance characteristic and types of fuel cell and also hydrogen as fuel, conversion to energy and Applications.	1	3	2			1	2

3: Strong contribution, 2: Average contribution, 1: Low contribution

12.Brief description of self learning/E-learning component

1. NPTEL :: General - NOC:Non-Conventional Energy Resources
2. NPTEL :: Electrical Engineering - Non-Conventional Energy Systems

13. Books recommended:

1. Energy Technology Non-Conventional, Renewable and Conventional, S. Rao, Dr. B. B. Parulekar, Khanna Publications, 3rd Ed, 2005
2. Non-Conventional Energy Sources, G. D. Rai, Khanna Publications, 2000
3. Solar Energy Utilisation, G.D.Rai, Khanna Publishers (1996)
4. Non-Conventional Energy Resources, Khan B. H., Tata McGraw Hill. 2006
5. Solar Energy Conversion, S. P. Sukhatne(2nd editions)
6. Hydrogen as an Energy carrier Technologies systems Economy-Winter & Nitch
7. Solar Energy Conversion – A. E. Dixnon & J. D. Leslie.