BHARATHIAR UNIVERSITY, COIMBATORE – 46

M.Sc., (Physics) – Choice Based Credit System (CBCS)

(From the academic year 2018-2019 onwards)

Programme Objective:

Physics principles and laws govern the celestial bodies to the nano-sized bodies and the use of which permeates in most of the advanced development in Science, Engineering and Technology. There is always a significant interest in physics since it caters the needs of the inter-disciplines, research and development in various industrial sectors.

1. The M.Sc., (Physics) programme has been designed with the objective to provide basic foundations with a sound knowledge of underlying principles along with recent developments.

2. To acquire knowledge about the nature, concepts, methods, techniques and objectives in the core physics subjects like Classical Mechanics, Quantum Mechanics, Atomic and Molecular Spectroscopy, Statistical Mechanics, Nuclear Physics, Condensed Matter Physics, Optics, Semiconductor Physics, etc.,

3. To develop an enhanced skill set that will put the learners at an advantage in careers as diverse as physics, bio-physics, bio-chemistry, quantum chemistry, applied mathematics, educationand computer science.

4. This programmeoffers the professional skills necessary for the students to play a meaningful role in industrial and academic career at national and international level.

Eligibility for Admission:

A candidate who have passed B.Sc. degree examination with Physics as Major and Mathematics and Chemistry as Ancillary subjects.

BHARATHIAR UNIVERSITY, COIMBATORE – 46
M.Sc. PHYSICS (UNIVERSITY DEPARTMENT)
(For the students admitted during the academic year 2018-19 onwards)

COURSE OF STUDY AND SCHEME OF EXAMINATION (CBCS PATTERN)

Semester	Subject Code	Subject		Exam: Duration (Hrs)	Exam: Internal	Exam: External	Exam: Total	Credit
I	18PHYC01	Core – 1	Classical Mechanics	3	25	75	100	4
	18PHYC02	Core – 2	Mathematical Physics - I	3	25	75	100	4
	18PHYC03	Core – 3	Condensed Matter Physics - I	3	25	75	100	4
	18PHYE01A 18PHYE01B	Elective – 1	Electronics (Or) Molecular Physics	3	25	75	100	4
	18PHYL01	Lab -1	Electronics Lab	6	25	75	100	4
	-	Supportive	Offered from other Departments	2	12	38	50	2
II	18PHYC04	Core – 4	Quantum Mechanics - I	3	25	75	100	4
	18PHYC05	Core – 5	Mathematical Physics - II	3	25	75	100	4
	18PHYC06	Core – 6	Condensed Matter Physics - II	3	25	75	100	4
	18PHYE02A 18PHYE02B	Elective – 2	Computational Methods &Programming (Or) Data Analysis Techniques	3	25	75	100	4
	18PHYL02	Lab - 2	Computational Programming Lab	6	25	75	100	4
	-	Supportive	Offered from other Departments	2	12	38	50	2
III	18PHYC07	Core –7	Quantum Mechanics - II	3	25	75	100	4
	18PHYC08	Core – 8	Electromagnetic Theory	3	25	75	100	4
	18PHYC09	Core – 9	Nuclear and Particle Physics	3	25	75	100	4
	18PHYE03A 18PHYE03B	Elective -3	Thermodynamics & Statistical Mechanics (Or) Materials Physics &Processing echniques	3	25	75	100	4
	18PHYL03	Lab - 3	Advanced Physics Lab	6	25	75	100	4
	-	Supportive	Offered from other Departments	2	12	38	50	2
IV	18PHYC10	Core – 10	Modern Optics	3	25	75	100	4
	18PHYC11	Core – 11	Semiconductor Devices	3	25	75	100	4
	18PHYC12	Core – 12	Atomic Physics&Molecular Spectroscopy	3	25	75	100	4
	18PHYL04	Lab - 4	Optics and LASER Lab	3	25	75	100	4
	18PHYP01		Project	3	50	150	200	8
					Total		**2250**	**90**

Note: In addition to the above, the students has to take any online course from Swayam, Coursera etc., for two additional credits which may be availed at any time during the course of study.

<u>Supportive offered to students of other departments</u>

1. Basic Electronics (Odd Semester – 18PHYS01)
2. Energy Resources (Even Semester-18PHYS02)

1. **<u>Theory Papers</u>** (Core– 12 x 4 = 48 Credits, Elective– 3 x 4 = 12 credits, Supportive– 3 x 2 = 6 Credits)

Question paper pattern for Core and Elective courses

<table>
<tr><td>External Exam</td><td>Maximum Marks</td><td>75 Marks</td><td>Duration</td><td>3 Hours</td></tr>
<tr><td colspan="4">Part – A
• Answer ALL questions
• Two questions from each unit
• Of the ten questions 5 must be of objective type with 4 choices
• Remaining 5 questions are of the type, Definition, Statement, Principle, Formula, Theorem</td><td>10 x 1 = 10 Marks</td></tr>
<tr><td colspan="4">Part – B
• Answer ALL questions
• One question from each unit with internal choice of either or type
• Outof the total ten questions 2questions must be problem oriented</td><td>5 x 5 = 25 Marks</td></tr>
<tr><td colspan="4">Part – C
• Answer ALL questions
• One question from each unit with internal choice of either or type
• Out of the total ten questions 2 questions must be problem oriented</td><td>5 x 8 = 40 Marks</td></tr>
</table>

<table>
<tr><td>Internal Exam</td><td>Maximum Marks</td><td>30 Marks</td><td>Duration</td><td>2 Hours</td></tr>
<tr><td colspan="4">Part – A
• Answer ALL questions
• Of the four questions 2 must be of objective type with 4 choices
• Remaining 2 questions are of the type, Definition, Statement, Principle, Formula, Theorem</td><td>4 x 1 = 4 Marks</td></tr>
<tr><td colspan="4">Part – B
• Answer ALL questions
• Two questions from the portion with internal choice of either or type
• Outof the total four questions 1question must be problem oriented</td><td>2 x 5 = 10 Marks</td></tr>
<tr><td colspan="4">Part – C
• Answer ALL questions
• Two questions from the portion with internal choice of either or type
• Out of the total four questions 1 question must be problem oriented</td><td>2 x 8 = 16 Marks</td></tr>
</table>

2. **<u>Distribution of Continuous Internal Assessment Marks:</u>**

<table>
<tr><td>Written Exam</td><td colspan="2">15 Marks (Average of best two out of three exams)</td></tr>
<tr><td>Assignment/Seminar</td><td colspan="2">5 Marks (A seminar within the/ related contents of the course</td></tr>
<tr><td rowspan="6">Attendance</td><td colspan="2">Maximum of 5 Marks</td></tr>
<tr><td>90% and Above</td><td>5 Marks</td></tr>
<tr><td>85 to 90 %</td><td>4 Marks</td></tr>
<tr><td>80 to 85 %</td><td>3 Marks</td></tr>
<tr><td>75 to 80 %</td><td>2 Marks</td></tr>
<tr><td>70 to 75 %</td><td>1 Mark</td></tr>
</table>

3. <u>Lab Courses</u>(4 Labs – 4 x 4 = 16 Credits)

External Exam	Maximum Marks	75 Marks	Duration	6 Hours
Distribution of Marks				
Practical Record				20 Marks
Formula with explanation, Algorithm, Flowchart, Diagram, Tables				20 Marks
Readings, Calculations, Programs,				30 Marks
Correct Results with proper units				5 Marks

Internal Exam	Maximum Marks	25 Marks	Duration	6 Hours
Distribution of Marks				
Observation				10 Marks
Model Exam				5 Marks
Record submission				5 Marks
Attendance				5 Marks

4. <u>Project Course</u>(8 Credits) – Total of 200 Marks

Internal Marks: Maximum 50 Marks

(Marks to be awarded by the supervisor, based on the consistence progress of the research work, skill, basic understanding of the problem, regular attendance in the lab, presentation, discussion etc.,)

External Marks: Maximum 150 Marks

<u>100 – Marks – For the duly completed project report</u>

(Marks to be awarded by the supervisor in consultation with the external examiner, based on the presentation of the project report in a bind form, with proper contents, introduction and literature related to the problem chosen, results and discussions supported by necessary figures, tables, references)

<u>50 – Marks – For the presentation by the student in the Viva-Voce exam</u>

(Marks to be awarded by the external examiner in consultation with the internal examiner based on testing the basic understanding, lucid presentation, grasp of the problem, confidence, mode of communication)

SEMESTER – I	CLASSICAL MECHANICS	CORE - 1
18PHYC01	**Teaching hours - 5Hours / Week**	**Credits - 4**

Objectives

- This course introduces the mathematical structure of theoretical physics. The students should able to correlate the conservation of fundamental physical concepts with symmetries
- The Newtonian mechanics needed for understanding the motion of a system of particles and the associated forces will be introduced. The motion of celestial bodies, and the governing differential equations,the dynamics and kinematics of he rigid bodies will be introduced.
- The concept of generalized coordinates needed for elimination of constraints, notion of configuration and phase space, variational principles, invariance under transformations will be constructed as a framework to understand the Lagrangian, Hamiltonian and Hamilton-Jacobi formalism for describing the dynamics.
- The importance of normal modes of vibrating systems and the basic concepts of relativity will be introduced.

Unit – I: Mechanics of Single and Systems of Particles

Newton's laws of motion, Mechanics of a particle, Equation of motion of a particle - Motion of a particle under constant force, the law of gravitational and electrostatic forces, motion under a force which depends on time only and motion of a particle subjected to resistive force. Mechanics of systems of particles - Angular momentum of the system - Potential and kinetic energies of the system- Degrees of freedom - Constraints - Motion in a central force field - Motion of two particles equivalent to single particle - Equation of motion of center of mass with respect to center of force - Motion in an inverse-square law force field equation of the orbit, - differential equation of trajectory - Kepler's Law of planetary motion.

Unit – II: Collisions of Particles and Motion of Rigid Body

Elastic and inelastic scattering - Laboratory and center of mass systems - Relations between different quantities in the laboratory and center of mass systems –Kinematics of elastic scattering in the laboratory system, Loss of kinetic energy - Inelastic scattering in the laboratory frame - Motion of a rigid body -Euler's theorem - Angular momentum and kinetic energy - Inertia tensor - Euler's equation of motion – Torque Free Motion – Euler's angles.

Unit – III: Lagrangian and Hamiltonian Formulations

Generalised coordinates - Hamilton's variational principle - Lagrange's equations of motion –Conservation theorems and symmetry properties – Cyclic coordinates - Application of Lagrange's equation; Linear harmonic oscillator, particle moving under a central force, Atwood's machine - Hamilton's equations of motion - Application of Hamiltonian's equations of motion; Particle moving in an electromagnetic field - Phase space - Principle of Least action.

Unit – IV: Canonical Transformations and Poisson Brackets

Canonical transformations – Generating function – Properties of canonical transformations, condition for a transformation to be canonical, Poisson brackets – Properties of Poisson brackets, Equations of motion in Poisson bracket, Angular momentum and Poisson brackets, Poisson's Second Theorem, Invariance of Poisson bracket under canonical transformation, Motion as successive canonical transformation (Infinitesimal generators), Liouville's theorem, The Hamilton Jacobi Equation,- Principal and characteristic function - Solution of harmonic oscillation problem by H-J method, Action and angle variables.

Unit – V: Small Oscillations and Relativity

Small oscillations - Stable and unstable equilibrium - Lagrange's equation of motion for small oscillations - Normal coordinates and normal frequencies - Small oscillations of particles on string - Free vibrations of a linear triatomic molecule – Two carts connected with three springs, Double pendulum.

Galilean transformation- Invariance of Newton's law, Lorentz transformation, Postulates of special theory of relativity, Time dilation – Length contraction- Mass energy equivalence – Invariant mass – Relativistic momentum.

Books for Study and Reference

No.	Title	Author	Publisher	Year
1.	Classical Mechanics	H.Goldstein, C. Poole and J.Safko	Pearson 3rdEdition	2014
2.	Introduction to Classical Mechanics	R. G. Takwale and P. S. Puranik	Tata McGraw-Hill	2006
3.	Classical Mechanics	John R. Taylor	University Science Books	2005
4.	Classical Mechanics	J.C. Upadhyaya	Himalaya Publishing House	2005
5.	Classical Mechanics	Gupta, Kumar and Sharma	Pragati Prakashan	2001
6.	Classical Mechanics	R. Douglas Gregory	Cambridge University press	2008
7.	Classical Mechanics	G. Aruldass	PHI Learning Private Ltd	2009

Tutorial (This portion is not intended for examination)

1. A particle is projected vertically upwards with speed u and moves in a vertical straight line under uniform gravity with no air resistance, find the maximum height achieved by

the particle and the time taken for it to return to its starting position.

2. A body of mass m is suspended from a fixed point by a light spring and moving under uniform gravity. The spring is found to be extended by a distance b. Find a period of oscillations of the body about this equilibrium position (assume there is a small strain).

3. Find the moment of inertia of a uniform circular disk of mass M and radius a about its axis of symmetry.

4. Find the kinetic energy of rotation of a rigid body with respect to the principle axes in terms of Eulerian angles.

5. Simple pendulum with rigid support, and with variable length.

6. Triple pendulum.

Learning Outcomes
On successful completion of the course, students will able to: 1. Explain the concepts such as degrees of freedom, constraints, needed for f Newtonian mechanics and apply them to mechanical systems 2. Explain the concept of generalized coordinates, Phasespace and understand the physical principle of Lagrange and Hamilton's equations, and the advantages of these formulations. 3. Construct the Lagrangian and Hamiltonian and solve equations of motion for simple one and two body system, rigid bodies, coupled oscillators. 4. Relate symmetries to conservation laws in physical systems, and apply these concepts to practical situations, 5. Solve orbit problems using the conservation of angular momentum and total energy and understand the fundamental principles of the special theory of relativity.

Course Prepared By:	**Course Verified By:**
Dr. M. Balasubramaniam and Dr. R. Shankar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	MATHEMATICAL PHYSICS – I	CORE - 2
18PHYC02	Teaching hours - 5 Hours / Week	Credits – 4

Objectives

- To expose students to solve problems with different methods of matrix
- To provide knowledge on various analytical methods used for solving differential equations.
- To teach students about the special type of differential equations with their properties and their solution.
- To expose students to learn about Laplace transforms and uses
- To provide knowledge on Fourier's series, integral and transform

Unit-I: Matrices and Determinants

Properties of matrix addition and multiplication – different type of matrices and their properties – Rank of a Matrix and some of its theorems – Solution to linear homogeneous and non-homogeneous equations – Cramer's rule – Eigenvalues and eigenvectors of matrices – differentiation and integration of matrix.

Unit-II: Solving of differential equations

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

Unit-III: Special differential equations and their solutions

Legendre's differential equation: Legendre polynomials – Generating functions – Recurrence Formulae–Rodrigue's formula–orthogonality of Legendre's polynomial; Bessel's differential equation: Bessel's polynomial –generating functions–Recurrence Formulae–orthogonal properties of Bessel's polynomials; Hermite differential equation– Hermite polynomials – generating functions – recurrence relation; Laguerre's differential equation: Laguerre's polynomial –generating function–Recurrence Formulae–orthogonal properties of Laguerre's polynomials

Unit-IV: Laplace Transforms

Laplace transforms: Linearity property, first and second translation property of LT – Derivatives of Laplace transforms – Laplace transform of integrals – Initial and Final value theorems; Methods for finding LT: direct and series expansion method, Method of differential equation; Inverse Laplace transforms: Linearity property, first and second translation property, Convolution property – Application of LT to differential equations and boundary value problems.

Unit-V: Fourier series, integrals and transform

Fourier series definition and expansion of a function x – Dirichlet's conditions- Complex representation of Fourier series – problems related to periodic functions – Fourier integrals – convergence of FS – solving simple partial differential equations using Fourier's series- Fourier transforms: sin, cosine & complex transforms- solving simple partial differential equations using Fourier transform.

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Mathematical methods for Physics	G. Arfken	Elsevier, 6th edition	2010
2.	Mathematical Physics	B.D.Gupta	Vikas Publishing House, 4^{th} edition	2010
3.	Topics in Mathematical Physics	Parthasarathy H	Ane Books Pvt. Ltd	2007
4.	Mathematical Physics	Rajput	Pragati Prakasam, 17^{th} Edition	2004
5.	Advanced Engineering mathematics	Erwin Kreyszig	Wiley Eastern Limited, 7^{th} Edition	1993

Learning Outcomes

On successful completion of the course, students will able to:

1. Choose the right matrix method to solve set of linear equations
2. Solve differential equations with various methods
3. Solve differential equations using special functions
4. Solve both ordinary and partial differential equations using Laplace transform
5. Solve partial differential equations using Fourier's series and transform

Course Prepared By:	**Course Verified By:**
Dr. K. Ramachandran and Dr. L. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	**CONDENSED MATTER PHYSICS - I**	**CORE - 3**
18PHYC03	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives
This course gives an introduction to solid state physics with a primarytheme to study the basic theory of structure, composition and physicalproperties of crystalline materials. Concepts like reciprocal space, Brillouinzones, structure determination by diffraction will be explained correlatingthe structure and band structure of the crystals. Lattice vibrations, thecontinuum approximation, phonons, heat capacity will be explained to knowthe correlation between the structure and thermal properties of thematerials.

Unit – I: Fundamentals of Crystallography and Bonding in solids

Crystalline state – Basic definitions – Bravais lattices and crystal systems – Elements of symmetry – Crystal directions – Miller indices - Simple Crystal structures (NaCl, CsCl, Hexagonal close packed structure, Diamond structure, Cubic ZnS structure).

Forces between atoms – Ionic bonding – Bond dissociation energy of NaCl molecule – Cohesive energy of ionic crystals – Evaluation of Madelung constant for NaCl structure – The Born-Haber Cycle – Covalent bonding – Metallic bonding – Hydrogen bonding – Van Der Waals bonding.

Unit – II: Diffraction of waves and particles by crystals

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

Unit- III: Crystal Imperfections and Atomic Diffusion

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polorans – Excitons.

Ficks first and second law - solutions to Ficks second law – Applications of diffusion – Diffusion mechanism – Random walk treatment of diffusion – Kirkendall effect - diffusion in alkali halides - ionic conductivity in alkali halides.

Unit-IV: Lattice vibrations and thermal properties

Lattice vibrations: One dimensional monoatomic lattice-Dispersion relation-cutt off frequency- phase and group velocity- One dimensional diatomic lattice-Dispersion relation-Brillouin zone-acoustic and optical branches-density of states-scattering of phonons by phonons

Thermal properties: Lattice specific heats-classical theory-Einstein theory-Debye theory of atomic heat-thermal expansion-Gruneisen parameters-thermal conductivity-Normal and Umklapp processes

Unit-V: Free electron theory of metals and Energy bands

Free electron theory basics: Density of states-Fermi Dirac statistics-specific heat-relaxation time-mean free path-mobility-thermal conductivity-Drude model electrical conductivity-Wiedemann Franz Lorentz relations-Hall effect

Energy Band Theory: Periodic Potential-Bloch Theorem-Kronig-Penney model-Reduced zone scheme-Effective mass of electron-Nearly free electron model-tight binding model-Wigner Seitz Method-Basics of Augmented plane wave method

Fermi surface: Introduction Fermi surfaces-characteristics of Fermi surfaces-Construction of Fermi surfaces-Fermi surface and Brillouin zones-Fermi surfaces in metals Experimental study of Fermi surfaces: Anomalous Skin Effect-Magneto Resistance-dHvA effect (de Haas van Alphen effect)-cyclotron resonance

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Elementary Solid State Physics: Principles and Applications	M.A.Omar	Pearson Education Pvt. Ltd, 4th Edition	2004
2.	Solid State Physics: Structure and Properties of Materials	A.M.Wahab	Narosa Publishing House, 2nd Edition	2007
3.	Introduction to Solid State Physics	C. Kittel	John –Wiley & Sons, 2nd Edition	2007
4.	Elements of Solid State Physics	J.P.Srivastava	Prentice Hall of India, New Delhi, 2nd Edition	2001
5.	Solid State Physics	S.O.Pillai	New Age International Publishers, 4th Edition	2001
6.	Solid State Physics	Ashcroft and Mermin	Eastern Press Pvt. Ltd, Bangalore, 1st Edition	2003
7.	Introductory Solid State Physics	H.P.Myers	Taylors and Francis Ltd, 2nd Edition	1998
8.	Solid State Physics	C. M. Kachhava	Tata McGraw-Hill Publishing Ltd	1990

Tutorials: (This portion is not intended for examination)

1. Calculate the number of atoms per unit cell for rock salt crystal. Given a = 5.63A^o, Mol. wt of NaCl = 58.5 and the density is 2180kg/m^3
2. Calculate the glancing angle on the plane (110) of a cube rock salt (a=2.81 A^o) corresponding to second order diffraction maximum for the X-rays of wavelength 0.71 A^o.
3. If the ionic radius of Na decreases by 0.88 and that of Cl increases by 0.89, calculate the binding energy of NaCl. Madelung constant for NaCl is 1.75 and n=9 for ionic crystals. Express your result in kJ/mol [r_{Cl} = 0.0905nm and r_{Na} = 0.186nm].
4. Calculate the spacing between dislocations in a tilt boundary in fcc copper crystal, when the angle of tilt is 10^o (Burgers vector = 2.6 A^o)
5. Use the Free electron theory to calculate the Fermi energy of Na and Al metals. Their lattice constants are 4.3 A^o and 4.0 A^o respectively.
6. The Fermi energy of Al is 12 eV and its electrical conductivity is 3 x $10^{-8}\Omega$m. Calculate the mean free path of the conduction electrons and their mean drift velocity in a field of 1000 Vm^{-1}. (For Al, the atomic weight = 27 and density = 2700 kg/m^3
7. The Fermi energy of copper is 7 eV. Calculate (a) The Fermi momentum of electron in copper, (b) the de Broglie wavelength of the electron and (c) the Fermi velocity.

Learning Outcomes
At the end of the course, the student should be able to 1. Describe different types of crystal structures in terms of the crystal lattice and the basis of constituent atoms 2. Formulate the theory of X-ray diffraction in the reciprocal lattice (k-space) 3. Describe the different physical mechanisms involved in crystal binding identifying the repulsive and attractive interactions and correlate these with the atomic properties 4. Formulate the theory of lattice vibrations (phonons) and use that to determine thermal properties of solids 5. Formulate the problem of electrons in a periodic potential, examine its consequence on the band-structure of the solid and develop a framework that explains the physical properties of solids in terms of its band-structure

Course Prepared By:	**Course Verified By:**
Dr. D. Nataraj and Dr. R. Kalaiselvan	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	**ELECTRONICS**	**ELECTIVE – 1** **CHOICE - 1**
18PHYE01A	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives
To give an insight to the students about fundamental concepts, techniques and applications of Op-amp, Digital electronic devices, Flip-flops, Counters and Electronics communications

Unit-I: Operational Amplifier

The ideal Op-Amp – Inverting, Non-inverting and Differential amplifiers (CMRR); Op-Amp IC building blocks – Emitter-coupled differential amplifier, Active load, Level shifting and Output stage; Op-Amp characteristics – Open-loop input-output characteristics, Frequency response and Slew rate; Op-Amp applications – Adder, Subtractor, Integrator, Differentiator, Comparator, Voltage-to-current converter, Current-to-voltage converter, Logarithmic amplifier, Active peak detector, Active first-order low-pass and High pass filter.

Unit-II: Combinational Logic Circuits and Data-Processing Circuits

Boolean laws and theorems – Basic laws, OR & AND operations, De Morgan's theorems, Duality theorem; Sum-of-Products method – Truth table of Karnaugh map– Karnaugh simplifications– Product-of-Sums method. Multiplexers – 16-to-1 Multiplexer, Multiplexer logic, Bubbles on signal lines, Universal logic circuit and Nibble multiplexers; Demultiplexers – 1-to-16 Demultiplexers; Decoders – 1-of-16 Decoder, BCD-to-Decimal decoders, Seven-Segment decoders; Encoders – Decimal-to-BCD Encoder.

Unit-III: Flip-Flops

Types of Flip-flops –RS Flip-flops, Clocked RS Flip-flops, Clocked D Flip-flops, Positive-Edge-Triggered RS Flip-flops, Negative-Edge-Triggered RS Flip-flops, Edge-Triggered D Flip-flops, Positive-Edge-Triggered JK Flip-flops, Flip-flop timing, JK Master-Slave Flip-flops, Conversion of SR Flip-flop to JK Flip-flop.

Unit-IV: Registers and Counters

Types of Registers – Serial in-Serial out, Serial in-Parallel out, Parallel in-Serial out, Parallel in-Parallel out. Types of Counters – Asynchronous (Ripple) counters, Synchronous counters, Decade counters.

Unit-V: Waveguides; Oscillators and Amplifiers

Waveguides – Rectangular waveguides: Properties of the TE_{10} mode, Standing waves, Waveguide terminations, Attenuators, Current in walls; Circular waveguides, Ridged waveguides. Oscillators and Amplifiers – Two-cavity Klystron amplifier, Four-cavity Klystron amplifier, Reflex Klystron Oscillator.

Books for Study and Reference:

No.	Title	Author	Publisher & Edition	Year
1.	Text Book of Electronics	S. Chattopadhyay	New Central Book Agency (P) Ltd., Kolkata.	2006
2.	Digital Principles and Applications	D.P. Leach, A.P. Malvino and G. Saha	Tata McGraw-Hill, Education Pvt Ltd., New Delhi& 6th Edition.	2009
3.	Electronics Principles and Applications	A.B. Bhattacharya	New Central Book Agency (P) Ltd., Kolkata.	2007
4.	Electronic Communications	Dennis Roddy and John Coolen	Prentice-Hall of India Pvt. Ltd, New Delhi& 4th Edition.	2008
5.	Electronics Communications	Sanjeeva Gupta	Khanna Publishers, Delhi & 2nd Edition.	2002

Tutorial (This portion is not intended for examination)

1. Suppose a three variable truth table has a high output for these input conditions: 000, 010, 100 and 110. What is the sum-of-products circuit?

2. A truth table has low outputs for inputs of 0000 to 0110, a high output for 0111, low outputs for 1000 to 1001, don't cares for 1010 to 1111. Show the simplest logic circuit for this truth table.

3. Suppose a truth table has a low output for the first three input conditions: 000, 001 and 010. If all other outputs are high, what is the product-of-sums circuit?

4. A sine wave with a peak of 6 V drives one of the inverters in a 7414 sketch the output voltage.

5. Examine the logic levels at the input of 54/74L91 and show how a 1 and then a 0 are shifted into the register.

6. A rectangular waveguide has a broad wall dimension of 0.9000 in. and is fed by a 10-GHz carrier from a coaxial cable. Determine whether a TE_{10} wave will be propagated, and, if so, find its guide wavelength, phase, and group velocities.

Learning Outcomes
At the end of the course, the student should be able to 1. Demonstrate knowledge of operational amplifiers and their applications. 2. Apply Boolean algebra and the Karnaugh map as tools in designing and to simplifying digital logic circuits. 3. Know the fundamental concepts and techniques used in data storage elements. 4. Understand the behaviour of a register with additional control signals. Know the shift registers can be used to implement counters. 5. Understand and solve the waveguide propagation equations (rectangular and circular waveguides).

Course Prepared By:	**Course Verified By:**
Dr. K. Srinivasan and Dr. K. Suresh	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	MOLECULAR PHYSICS	ELECTIVE – 1 CHOICE - 2
18PHYE01B	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives

- To provide the fundamental knowledge on the structure and dynamics of the molecules through various theories
- Studying the relation between molecular interactions and properties
- Providing phenomenological theories on reaction dynamics and transport properties

Unit-I: Molecular structure and bonding

Chemical bonding - The VSEPR model - Valence bond theory – The hydrogen molecule - Homonuclear diatomic molecules - Polyatomic molecules - Molecular orbital theory – Homonuclear diatomic molecules – Heteronuclear diatomic molecules – Bond properties - Polyatomic molecules - Molecular shape in terms of molecular orbitals - Molecular structure, properties and conformations

Unit-II: Molecular symmetry

Symmetry elements and operations – The symmetry classification of molecules – Some immediate consequences of symmetry – Applications to molecular orbital theory – Character tables and symmetry labels – Vanishing integrals and orbital overlap - Vanishing integrals and selection rule

Unit-III: Molecular interactions and mechanics

Electric properties of molecules - Electric dipole moments - Polarizabilities - Relative permittivity's - Interactions between dipoles - Repulsive and total interactions - Molecular interactions in gases - Potential energy (force field) in molecular mechanics – Various energy terms in force field – Newtonian and Hamiltonian dynamics – Phase space trajectories

Unit-IV: Molecular reaction dynamics

Collision theory – Diffusion controlled reactions – Reactive collisions – Potential energy surfaces – Transition state theory – The Eyring equation – Thermodynamic aspects - Microscopic–macroscopic connection - Zero-point Vibrational energy - Molecular electronic, rotational, Vibrational and translational partition functions

Unit-V: Electron transfer, electronic structure and spectra

The rates of electron transfer processes – Theory of electron transfer processes – Crystal-field theory - Ligand-field theory - Electronic spectra of atoms - Electronic spectra of complexes - Charge-transfer bands - Selection rules and intensities - Luminescence

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Physical chemistry	P.Atkins and J. Depaula	Oxford University Press	2009
2.	Inorganic chemistry	P. Atkins, T. Overton , J. Rourke and M. Weller	Oxford University Press	2009
3.	Essential of Computational Chemistry - Theories and Models	Christopher J. Cramer	John Wiley & Sons, 2nd Edition	2004

Tutorial (This portion is not intended for examination)

1. Determine the bond orders of (a) S_2, (b) Cl_2, and (c) NO_2 from their molecular orbital configurations and compare the values with the bond orders determined from Lewis structures. (NO has orbitals like those of O_2.)
2. When a He atom absorbs a photon to form the excited configuration 1s12s1 (here called He*) a weak bond forms with another He atom to give the diatomic molecule HeHe*. Construct a molecular orbital description of the bonding in this species.
3. Use symmetry properties to determine whether or not the integral $\int p_x z p_z d\tau$ is necessarily zero in a molecule with symmetry C_{4v}.
4. The polarizability volume of NH_3 is $2.22x10^{-30}$ m^3; calculate the dipole moment of the molecule (in addition to the permanent dipole moment) induced by an applied electric field strength 15 kV m^{-1}.
5. A rate constant is found to fit the expression $k_2 = (6.45x10^{13})\ e^{-(5375\ K)/T}\ dm^3\ mol^{-1}\ s^{-1}$ near 25˚C. Calculate $\Delta^{\ddagger}G$ for the reaction at 25˚C.

Learning Outcomes
At the end of the course, the student should be able to 1. Understand the bulk properties of matter in-terms of molecular architecture, interactions and dynamics. 2. Understand the reaction mechanism and transport properties of the matter

Course Prepared By:	**Course Verified By:**
Dr. K. Senthilkumar and Dr. L. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	**ELECTRONICS LAB**	**LAB - 1**
18PHYL01	**Teaching hours - 6 Hours / Week**	**Credits – 4**

Objectives

- To give hands on training in the construction of simple electronics circuits
- To make the students understand practically the characteristics of transistors, amplifiers, oscillators and filters.
- To give exposure in understanding digital to analog and analog to digital conversion, use of logic gates etc.,

No.	Experiment
1.	Study the forward and reverse characteristics of a Zener diode.
2.	Construction of adder, subtractor, differentiator and integrator circuits using the given OP – Amp.
3.	Study the static and drain characteristics of a JFET.
4.	Construction of an Astable multivibrator circuit using transistors.
5.	Study the characteristics of UJT.
6.	Construction of a single FET amplifier with Common Source configuration.
7.	Construction of a relaxation oscillator circuit using the given UJT and study its performance.
8.	Construction a single stage RC coupled amplifier using transistor and study its frequency responses.
9.	Construction of a two stage RC coupled amplifier using transistor and study its frequency responses.
10.	Construction of A/D converter circuit and study its performance.
11.	Construction of D/A converter circuit and study its performance.
12.	Construction of half-adder and full-adder circuits using NAND gates and study their performance.
13.	Construction of half- subtractor and full- subtractor circuits using NAND gates.
14.	Construction of a bi-stable multivibrator circuit using transistors and study its performance.
15.	Construction of a phase shift oscillator circuit using the given transistor and study its

	performance.
16.	Construction of a Wien’s bridge oscillator circuit using transistor and study its performance.
17.	Construction of a low-pass filter circuit and study its output performance.
18.	Construction of a high-pass filter circuit and study its output performance.
19.	Construction of a band-pass filter circuit and study its output performance.
20.	Construction of a voltage regulated power supply using Zener diode.

Learning Outcomes

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

1. Construct simple electronics circuits
2. Understand the theoretical concepts by doing experiments
3. Understand the characteristics of transistors, amplifiers, oscillators and filters.
4. Understand the conceptual difference between analog and digital electronics.

Course Prepared By:	**Course Verified By:**
Dr. K. Srinivasan and Dr. K. Suresh	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	QUANTUM MECHANICS – I	CORE - 4
18PHYC04	Teaching hours - 5 Hours / Week	Credits – 4

Objectives

- To enable the students, learn the basic postulates of quantum mechanics.
- Relate the knowledge of mathematics to the formalism of quantum mechanics
- Introduce applications of Quantum Mechanics in microscopic particle regime

Unit-I: General formalism of quantum mechanics

Linear Vector Space- Linear Operator- Eigenfunctions and Eigenvalues- Hermitian Operator- Postulates of Quantum Mechanics- Simultaneous Measurability of Observables- General Uncertainty Relation- Dirac's Notation- Equations of Motion; Schrodinger, Heisenberg and Dirac representation- momentum representation- Density Matrix and its properties

Unit-II: Energy Eigenvalue problems

Particle in a box – Linear Harmonic oscillator- Tunnelling through a barrier- particle moving in a spherically symmetric potential- System of two interacting particles-Rigid rotator- Hydrogen atom: Separation of the center of mass motion-solution to radial equation

Unit-III: Angular Momentum

Orbital Angular Momentum-Spin Angular Momentum-Total Angular Momentum Operators- Commutation Relations of Total Angular Momentum with Components- Ladder operators-Commutation Relation of J_z with J_+ and J_- - Eigen values of J^2, J_z- Matrix representation of J^2, J_z, J_+ and J_- - Addition of angular momenta- Clebsch -Gordon Coefficients: selection rules – recursion relations-computation of Clebsch -Gordon Coefficients

Unit-IV: Approximate Methods

Time Independent Perturbation Theory in Non-Degenerate Case -- Degenerate Case - Stark Effect in Hydrogen atom – Spin-orbit interaction - Variation Method – Born-Oppenheimer approximation - WKB Approximation and its validity

Unit-V: Many Electron Atoms

Indistinguishable particles – Pauli principle- Inclusion of spin – spin functions for two-electrons- The Helium Atom – Central Field Approximation - Thomas-Fermi model - Hartree - Fock method for many electron system.

Books for Study and Reference:

No.	Title	Author	Publisher & Edition	Year
1.	A Text Book of Quantum Mechanics	P.M. Mathews & K. Venkatesan	Tata McGraw Hill	2010
2.	Quantum Mechanics	G. Aruldhas	Prentice Hall of India	2008
3.	Introduction to Quantum Mechanics	David J.Griffiths	Cambridge University Press	2016
4.	Quantum Mechanics	L.I Schiff	McGraw Hill	2010
5.	Quantum Mechanics - Concepts and Applications	N. Zettili	Wiley	2016
6.	Quantum Mechanics	V. Devanathan	Alpha Science Intl Ltd	2011
7.	Principles of Quantum Mechanics	R.Shankar	Springer	2005

Tutorial: (This portion is not intended for examination purpose)

1) Plotting of harmonic oscillator wavefunctions
2) Problems involving matrix representations of an operator
3) Alpha emission – WKB approximation
4) Kronig-Penney Square-well periodic Potential

Learning Outcomes
At the end of the course, the student should be able to 1. apply principles of quantum mechanics to calculate observables on known wave functions 2. solve time-independent Schrödinger equation for simple potentials 3. combine spin and angular momenta 4. apply approximate methods to solve simple problems

Course Prepared By:	**Course Verified By:**
Dr. L. Senthilkumar and Dr. K. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	**MATHEMATICAL PHYSICS – II**	**CORE - 5**
18PHYC05	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives

- To expose students to solve problems with different methods of matrix
- To teach about basic properties of complex functions and related theorems
- To expose students to different types of groups and their properties.
- To provide knowledge on various analytical methods used for solving differential equations.
- To impart the knowledge on tensors and their properties

Unit –I: Vector Analysis

The Scalar and vector fields – Gradient, divergence and curl – Orthogonal curvilinear coordinates – Cylindrical and spherical coordinates as a special curvilinear system – Vector integration – Line, surface and volume integrals – Gauss divergence theorem - Stokes theorem in the space - Green's theorem in the plane.

Unit – II: Complex Variables

Complex Algebra- Argand diagram- Properties of Moduli and arguments- Cauchy-Riemann Conditions-Cauchy's integral Theorem- Cauchy's integral formula-Taylor's and Laurent's expansion- Singularities- Mapping- Conformal mapping- Cauchy's residue theorem-Computation of residue – Evaluation of integral.

Unit – III: Group Theory

Definition of Group - Subgroup, invariant group, abelian group, orthogonal and unitary groups -Homomorphism, isomorphism - Reducible and irreducible representations - Generators of Continuous groups.

Unit – IV: Gamma, Beta, and Error functions

Definition of Gamma and Beta functions- Fundamental properties of Gamma functions – Evaluation of $\Gamma(1/2)$ and graph of the Gamma function- Transformation of Gamma function - Different forms of Beta functions – Relation between Beta and Gamma functions- Reduction of definite integrals to Gamma functions- Error function / probability integral.

Unit – V: Tensor Analysis

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

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Mathematical methods for Physics	G. Arfken	Elsevier, 6th edition	2010
2.	Mathematical Physics	B.D.Gupta	Vikas Publishing House , 4th edition	2010
3.	Topics in Mathematical Physics	Parthasarathy H	Ane Books Pvt. Ltd	2007
4.	Mathematical Physics	S.D. Joglekar	Universities Press Pvt.Ltd, 1st Edition	2005
5.	Mathematical Physics	H.K. Dass and R. Verma	S. Chand Company, 2nd Edition	2001
6.	Advanced Engineering mathematics	Erwin Kreyszig	Wiley Eastern Limited, 7th Edition	1993

Learning Outcomes

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

1. Choose right method to solve problems in physics.
2. Integrate various functions with singularities
3. Characterise the physical system using group operations and table
4. Classify the differential equations and choose right method to solve problems
5. Transform a quantity between coordinate systems.

Course Prepared By:	**Course Verified By:**
Dr. K. Ramachandran and Dr. L. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	**CONDENSED MATTER PHYSICS – II**	**CORE - 6**
18PHYC06	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives
This course aims to give an extended knowledge of the principles and techniques of solid state physics. This course includes the fundamental properties of solid systems based on the classical and quantum physics principles. It also provides a valuable theoretical introduction and an overview of the fundamental applications of the physics of solids.Finally, it introduces the theoretical basis of nanotechnology and its potential applications

Unit – I: Theory of Dielectrics:

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

Unit – II: Theory of Ferroelectrics and Piezoelectrics

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

Unit – III: Magnetic Properties of Materials

Terms and definitions used in magnetism – Classification of magnetic materials – Atomic theory of magnetism – The quantum numbers- The origin of permanent magnetic moments – Langevin’s classical theory of diamagnetism – Sources of paramagnetism – Langevin’s classical theory of paramagnetism – Quantum theory of paramagnetism – Paramagnetism of free electrons - Ferromagnetism – The Weiss molecular field – Temperature dependence of Spontaneous magnetization – The physical origin of Weiss

Molecular field - Ferromagnetic domains - Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

Unit – IV:Superconductivity

Sources of superconductivity – The Meissner effect – Thermodynamics of superconducting transitions – Origin of energy gap – Isotope effect - London equations – London Penetration depth – Type I and Type II Superconductors - Coherence length – BCS theory – Flux quantization – Theory of DC and AC Josephson effect – Potential applications of superconductivity.

Unit – V: Physics of nanosolids

Definition of nanoscience and nanotechnology – Preparation of nanomaterials – Surface to volume ratio – Quantum confinement – Qualitative and Quantitative description – Density of states of nanostructures – Excitons in Nano semiconductors – Carbon in nanotechnology – Buckminsterfullerene – Carbon nanotubes – Nanodiamond – BN nano tubes – Nanoelectronics – Single electron transistor – Molecular machine – nanobiometrics.

Tutorial (This portion is not intended for examination)

1. Find the total polarizability of CO_2, if its susceptibility is 0.985 $x10^{-3}$. Density of CO_2 is $1.977kg/m^3$
2. The polarizability of oxygen atoms in the air molecules is 9.7 $x10^{-41}cm^2/V$. Calculate the average distance of the center of negative charge cloud from the nucleus.
3. A paramagnetic material has 10^{28} atoms/m^3. The magnetic moment of each atom is 1.8 $x10^{-23}$ Am^2. Calculate the paramagnetic susceptibility at room temperature (300 K). If A bar magnet of 0.1 m long and 1 cm^2 cross section constructed from this material is placed in a field of 8 $x10^4$ A/m, determine its dipolemoment.
4. Diamagnetic Al_2O_3 is subjected to an external magnetic field of 105 A/m and its susceptibility is $5x10^{-5}$. Evaluate magnetization and magnetic flux density in it.
5. A given superconductor has critical fields 1.4 $x10^5$ and 4.2 $x10^5$ A/m at 14K and 13 K, respectively. Calculate its transition temperature and the critical field for 4.2 K.
6. The penetration depth of mercury at 3.5K is about $750A^o$. Estimate the penetration depth at 0 K. Also calculate the superconducting electron density.

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Solid State Physics: Structure and Properties of Materials	A.M.Wahab	Narosa Publishing House, 2^{nd} Edition	2007
2.	Solid State Physics	Rita John	Mc Graw Hill	2001

			Education, 1st Editon	
3.	Solid-State Physics: Introduction to the Theory	J.D. Patterson B.C. Bailey	Springer Publications	2007
4.	Elementary Solid State Physics: Principles and Applications	M.A.Omar	Pearson Education Pvt. Ltd, 4th Edition	2004
5.	Introduction to Solid State Physics	C. Kittel	John –Wiley & Sons, 2nd Edition	2007
6.	Solid State Physics	S.O.Pillai	New Age International Publishers, 4th Edition	2001
7.	Ferroelectrics	A.K. Bain, P. Chand	Wiley	2017
8.	Dielectric phenomena in solids with emphasis on physical concepts of electronic processes	Kwan Chi Kao	Elsevier Academic Press	2004
9.	Introduction to Nanoscience and Nanotechnology	K.K.Chattopadhyay, A.N.Banerjee	PHI Learning private Ltd., Delhi	2014

Learning Outcomes
Students should gain the fundamental knowledge of solid state physics. Especially, students should have an understanding of dielectric, ferroelectric and peizoelectric properties of the solid systems and its potental applications. This course will provide the deep understanding to elucidate the electrical, magnetic and optical properties of crystalline solids

Course Prepared By:	**Course Verified By:**
Dr. D. Nataraj and Dr. R. Kalaiselvan	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	COMPUTATIONAL METHODS AND PROGRAMMING	ELECTIVE – 2 CHOICE - 1
18PHYE02A	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives
To familiarize the students and to impart knowledge about accuracy of numerical calculations, finding zeros of linear, transcendental, simultaneous equations, regression using least square, interpolating methods, finding eigenvalues of matrices, integration of functions, tabulated data, methods of singular and oscillatory integrals, ordinary and partial differential equations, exposure to the scientific programming language Fortran, writing programs using Fortran for the numerical methods learned.

Unit – I Errors - Roots of equation – Simultaneous equations

Accuracy of approximate calculations: Absolute, relative and percentage errors – Relative error and the number of significant figures - General error formula – Error in a series approximation

Roots of equation: Bisection method – False position method – Newton Raphson method – Secant method – Order of convergence

Simultaneous Equations: Existence of solutions- Basic Gauss elimination method – Gauss elimination with partial pivoting – Gauss Jacobi iteration method – Gauss Seidal iteration method – Inversion of a matrix using Gauss elimination method – LU decomposition.

Unit – II Curve fitting – Interpolation

Curve fitting: Method of least squares – straight line, parabola , $y = ax^n$, $y = ae^{bx}$, $y = a+bx^n$ type curves – sum of squares of residuals for straight line and parabola fit – Weighted least squares approximation – Method of least squares for continuous functions

Interpolation:Polynomial Interpolation – Lagrange polynomial – Newton polynomial - Forward and Backward differences – Gregory Newton forward and backward interpolation formula for equal intervals – Divided difference – properties of divided differences – Newton's divided differences formula – Lagrange's interpolation formula for unequal interval – Linear spline – Quadratic spline interpolation

Unit – III Eigenvalues – Integration

Eigenvalues: Power method to find dominant Eigenvalue - Jacobi method – Eigenvalues of symmetric tri-diagonal matrix – House holder's and QR method

Integration:Newton – cotes formula – Trapezoidal rule, Simpson's rule, Simpson's 3/8 rule, Boole's rule– Error estimates in trapezoidal and Simpson's rule – Gauss quadrature – Numerical evaluation of singular integrals – Numerical calculation of Fourier integrals – Trapezoidal – Filon's formula

Unit – IV Differential Equations

Ordinary differential equation: Solution byTaylor's series – Picard's method for successive approximation - Basic Euler method – Improved Euler method – Modified Euler method – Runge Kutta fourth order method – RK4 method for simultaneous first order differential equation - RK4 Method for second order differential equation

Partial differential equation: Classification of partial differential equation of the 2ndorder - Difference quotients – Graphical representations of partial quotients – standard and diagonal five point formula for Laplace equations – solution of Laplace's equation (Liebman's iteration) – Parabolic equations – Bender Schmidt recurrence relation - Crank Nicolson formula - Hyperbolic equations – three level scheme

Unit – V Fortran programming and applications to numerical methods

Fortran programming:Algorithms - Flowcharts – Character Set - Constants - Variables – Subscripted variables – Operations - Input andoutput statements – File processing - Control statements (Do, If, Goto structures) - Function subprogram – Subroutine subprogram

Applications: Ascending, descending order, matrix manipulation, Root of an equation using Newton Raphson method - Matrix inversion using Gauss elimination – Straight line curve fitting – Newton's polynomial interpolation – Power method– Trapezoidal & Simpson's rule.

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Numerical Mathematical Analysis	J. B. Scarborough	Oxford Publishing, 6th Edition	1990
2.	Numerical methods for mathematics, science and engineering	John H. Matthews	Prentice Hall of India, 2nd Edition	2000
3.	Introductory methods of numerical analysis	S. S. Shastry	Prentice Hall of India,	2010
4.	Programming with Fortran 77	Ram Kumar	Tata Mc Graw Hill	1994
5.	Computer Applications in Physics	S. Chandra, M.K. Sharma	Narosa, 3rd Edition	2014

Learning Outcomes
After passing the course the student should be able to 1. Understand the importance of errors and accuracy of the numerical calculations and its practical implementation in the measurements 2. Find roots of different types of equations 3. Understand experimental data, its behavior and trend, regression 4. Understand various interpolating techniques and its relevance in various fields 5. Obtain the eigenvalues of matrices and understand its applicability in various physics aspects 6. Understand techniques to evaluate integrals bounded in a range, singular integrals and oscillatory integrals and its usage in various physics concepts. 7. Solve initial value and boundary value problems of ordinary and partial differential equations using different numerical techniques and its applicability in physics concepts. 8. Get an exposure to write scientific programming using Fortran and apply the skills learned for various techniques studied

Course Prepared By:	**Course Verified By:**
Dr. M. Balasubramaniam and Dr. K. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	DATA ANALYSIS TECHNIQUES	ELECTIVE – 2 CHOICE - 2
18PHYE02B	**Teaching hours - 5 Hours / Week**	**Credits – 4**

Objectives
• To learn the importance of error analysis, and various methods to analyse error • To effectively learn statistical tools needed for data analysis. • To understand the behaviour of distribution of data

Unit-1: Errors and its importance

Approximate numbers and Significant Figures – Rounding of Numbers – Absolute, Relative and Percentage errors – Relation between Relative error and the significant figures – The general formula for errors – Formulas to the fundamental operations of arithmetic and logarithms – Accuracy in the evaluation of a Formula – Accuracy in the Determination of arguments from a tabulated function – Accuracy of Series approximations – Errors in Determinants

Unit – 2: - Errors and curve fitting

Errors of Observations and Measurement – The law of accidental errors – The probability of errors lying between given limits – The probability equation – The law of error of a linear function of independent quantities – The probability integral and its evaluations – Theprobability of hitting a target – The principle of least squares – Weighted observations – Residuals – The most probable value of a set of direct measurements – Law of error for residuals – Agreement between theory and experience

Unit – 3: Probability Basics

Chance Experiments and Events – Definition of Probability – Basic Properties: Addition and multiplication laws of Probability – Conditional Probability, population, variants, collection, tabulation and graphical representation of data– Some General Probability Rules – Estimating Probabilities Empirically using Simulation -frequency distributions, averages or measures of central tendency, arithmetic mean, properties of arithmetic mean, median, mode, geometric mean, harmonic mean, dispersion, standarddeviation, root mean square deviation, standard error and variance, moments, skewness and kurtosis

Unit –4:Probability distributions

Random variables – Probability distribution of discrete random variables – Probability distribution for continuous random variables – Mean and Standard deviation of a random variable - Binomial and geometric distribution – Normal distributions - Poisson distribution - Gaussian distribution, exponential distribution – additive property of normal variants, confidence limits, Bi-varite distribution, Correlation and Regression, Chi-Square distribution

Unit – 5 Errors in measurements

Measurement, Direct and Indirect – Precision and Accuracy – Measures of Precision – Relations between the Precision measures – Geometric significance of μ, r and η – Relation between probable error, and the probable errors of the arithmetic and weighted means – Computation of the precision measures from the residuals – The combinations of sets of measurements when the P.E.'s of Sets are given – The probable error of any function of independent quantities whose P.E.'s are known – The two fundamental problems of indirect measurements – Rejection of observations and measurement

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Numerical Mathematical Analysis	J. B. Scarborough	Oxford and IBH Publishing Company, 6th Edition	1990
2.	Introduction to Statistics and Data Analysis	R. Peck, C. Olsen and J.L. Devore	Cengage Learning, 5th Edition	2014

Learning Outcomes
1. After completing this course, the student will be able to understand the importance of error analysis needed for measurements 2. Understand the importance of statistical tools required for analysis of experimental / simulation / theoretical data.

Course Prepared By:	**Course Verified By:**
Dr. M. Balasubramaniam and Dr. K. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – II	**COMPUTATIONAL PROGRAMMING LAB**	**LAB - 2**
18PHYL02	**Teaching hours - 6 Hours / Week**	**Credits - 4**

Objectives

- To provide hands on training to the students to write basic to advanced level scientific programming.
- To train the students to write programs to find numerical solutions / roots of linear, transcendental, simultaneous equations,
- To expose them to understand the regression analysis using least square procedure, interpolating methods, eigenvalues of matrices, integration of functions, tabulated data, methods of singular and oscillatory integrals, ordinary and partial differential equations,

No.	Program
1.	Ordering of numbers and characters (Ascending, Descending, Largest, Smallest)
2.	A Program to solve the quadratic equation
3.	Programming with matrices (Addition, Subtraction, Multiplication, Transpose)
4.	Root of equations – Bisection, False position, Newton-Raphson methods
5.	Solving system of linear equations - Gaussian elimination method
6.	Solving system of linear equations - Gauss Seidal method
7.	A Program for finding the inverse of a matrix – Gauss elimination method
8.	A Program for finding Eigenvalues of a symmetric matrix – Jacobi method
9.	Program for straight line curve fitting – Least squares procedure
10.	Program for polynomial curve fitting - Least squares procedure
11.	Program to integrate any function or tabulated data using the trapezoidal rule
12.	Program to integrate any function or tabulated data using Simpson's rule
13.	Program for numerical evaluation of singular integrals

14.	Program for numerical calculation of Fourier integrals
15.	Solving first order differential equation – Euler methods
16.	Solving first order differential equation – RK4 method
17.	Solving first order simultaneous differential equations – RK4 method
18.	Program for interpolation of equal interval – Newton's method
19.	Program for interpolation of unequal interval – Lagrange's method
20.	Solving parabolic partial differential equation
21.	Finding the solution of the radial part Schrödinger equation for the hydrogen atom
22.	A program to find the cooling rate of copper rod
23.	A program to find the charging and discharging rate of a condenser
24.	Program for periodic motion of simple harmonic oscillator
25.	Program to study the motion of charged particle in an uniform electric field.

Learning Outcomes

After passing the course the student should be able to write FORTRAN programs to

1. Find roots of different types of equations
2. Understand experimental data, its behavior and trend, regression
3. Understand various interpolating techniques and its relevance in various fields
4. Obtain the eigenvalues of matrices and understand its applicability in various physics aspects
5. Understand techniques to evaluate integrals bounded in a range, singular integrals and oscillatory integrals and its usage in various physics concepts.
6. Solve initial value and boundary value problems of ordinary and partial differential equations using different numerical techniques and its applicability in physics concepts.

Course Prepared By:	**Course Verified By:**
Dr. M. Balasubramaniam and Dr. K. Senthilkumar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – III	**QUANTUM MECHANICS – II**	**CORE - 7**
18PHYC07	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives
• To help the students to continue and deepen the theoretical understanding of quantum mechanics • To teach students how to develop formalism and interpretation of quantum mechanics

Unit I Time Dependent Perturbation Theory

Time Dependent Perturbation Theory-First and Second Order Transitions-Transition to Continuum of States-Fermi Golden Rule-Constant and Harmonic Perturbation- Collision-Adiabatic and Sudden Approximation- A Charged Particle in an Electromagnetic Field.

Unit II Scattering Theory

Scattering Amplitude - Expression in terms of Green's Function - Born Approximation and Its validity- Partial wave analysis - Phase Shifts – Asymptotic behavior of Partial Waves- The Scattering Amplitude in Terms of Phase Shift- Scattering by Coulomb Potential and Yukawa Potential.

Unit III Semi Classical Theory of Radiation

Absorption and Induced Emission: Maxwell's equations - Plane electromagnetic waves - Use of perturbation theory - Transition probability - Interpretation in terms of absorption and emission - Electric dipole transitions - Forbidden transitions.

Spontaneous Emission: Classical radiation field – Asymptotic form – Radiated Energy – Dipole radiation – Angular momentum – Dipole case – Conversion from classical to quantum theory – Planck distribution formula – Line breadth.

Unit IV Relativistic Wave Equation

Klein-Gordon Equation-Plane Wave Equation-Charge and Current Density-Application to the Study of Hydrogen Like Atom-Dirac Relativistic Equation for a Free Particle- Dirac Matrices -Dirac Equation in Electromagnetic Field - Negative Energy States.

Unit V Quantum Field Theory

Quantization of Wave Fields- Classical Lagrangian Equation-Classical Hamiltonian Equation - Field Quantization of the Non-Relativistic Schrodinger Equation-Creation, Destruction and Number Operators-Anti Commutation Relations-Quantization of Electromagnetic Field Energy and Momentum.

Books for Study and Reference:

No.	Title	Author	Publisher & Edition	Year
1.	A Text Book of Quantum Mechanics	P.M. Mathews & K. Venkatesan	Tata McGraw Hill	2010
2.	Quantum Mechanics	G. Aruldhas	Prentice Hall of India	2008
3.	Introduction to Quantum Mechanics	David J.Griffiths	Cambridge University Press	2016
4.	Quantum Mechanics	V. Devanathan	Alpha Science Intl Ltd	2011
5.	Quantum Mechanics	L.I Schiff	McGraw Hill	2010
6.	Principles of Quantum Mechanics	R.Shankar	Springer	2005
7.	Quantum Mechanics - Concepts and Applications	N. Zettili	Wiley	2016

Tutorial: (This portion is not intended for examination purpose)

1) Difference in collision process between Classical and Quantum identical particles.
2) Absorption and Emission of Radiation and its Selection Rules
3) Phase shift: Optical Theorem - Relation to the Potential- Potentials of finite Range
4) Partial Wave Analysis of Scattering from standard simple potential;
5) Application of time dependent perturbation theory of the semi classical theory of Radiation

Learning Outcomes
After passing the course the student should be able to 1. Apply the formalism for the analysis of various quantum mechanical systems 2. Apply the knowledge of non-relativistic and relativistic quantum mechanics, including time-dependent perturbation theory, scattering theory, relativistic wave equations, and quantum field theory.

Course Prepared By:	**Course Verified By:**
Dr. L. Senthilkumar and Dr. R. Shankar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – III	**ELECTROMAGNETIC THEORY**	**CORE - 8**
18PHYC08	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives

- To understand the nature of electric and magnetic force fields and the intricate connection between them.
- To develop a strong background in electromagnetic theory, understand and use various mathematical tools to solve Maxwell equations in problems of wave propagation and radiation.

Unit I: Electrostatics

Coulomb’s law – surface, line and volume charge distributions - Gauss’ Law and its applications; Electrostatic potential - Laplace and Poisson equations – Potential of a localized charged distributions – Laplace equation in one, two and three dimensions – Boundary conditions and Uniqueness theorems- Work and Energy in electrostatics - Conductors.

Unit II: Magnetostatics

Lorentz force law- Biot-Savart law – condition for steady electric current - Ampere's law – Application of Ampere’s law – comparison of Magnetostatics and Electrostatics – Magnetic vector and Scalar potential – Magneto static boundary conditions – Magnetic fields in matter- Magnetization – The field of a magnetized object.

Unit III: Electrodynamics

Electromotive force – ohms law – Faradays law – Induced electric field – Energy in magnetic fields – Maxwell’s equation in free space – Magnetic charge - Maxwell’s equation in matter – Boundary conditions - Conservation laws – Conservation of energy – Poynting’s theorem - conservation of momentum.

Unit IV: Electromagnetic waves & interaction with matter

Electromagnetic waves in vacuum – Energy and momentum of EMW – EMW in matter – Propagation in linear media – Reflection and transmission at Normal incidence – Reflection and Transmission at Oblique incidence – Implications: Laws of incidence and reflectance, snell’s law, Brewster law – Fresnel’s equations – wave guides- rectangular waveguide.

Unit V: Plasma Physics & Applications

Plasma – Plasma criteria – Debye shielding (DC current) – Plasma frequency (AC shielding) – Motion charge particles in uniform E and B field - non uniform B field – non uniform E field – time varying E field – time varying B field – guiding centre drifts – plasma confinement – Introduction to plasma diagnostics -Applications.

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Introduction to Electrodynamics	David J. Griffiths	Prentice Hall of India Pvt.Ltd, 3rd Edition	2000
2.	Classical Electrodynamics	J.D. Jackson	John Wiley-India, 3rd Edition	2011
3.	Introduction to Plasma Physics and Controlled Fusion	F. F. Chen	Springer (India) Pvt. Ltd, New Delhi, 2nd Edition	2006
4.	Foundations of Electromagnetic theory	J.R. Reity, F.J. Milford and R.W. Christy	Pearson. 4th Edition	2010
5.	Electromagnetic theory	P. K. Basu and H. Dhasmana	Ane Books Pvt. Ltd. New Delhi	2010
6.	Feynman Lectures	R. Feynman	Basic Books, Vol. 2	2011
7.	Classical Electrodynamics	Hans Ohanian	Firewall media, 2nd Edition	2009

Tutorial: (This portion is not intended for examination purpose)

1. Calculation of electric field around a charged sphere and wire
2. Representation of Divergence, Curl and gradient into Spherical and cylindrical coordinates

Learning Outcomes
After passing the course the student should be able to 1. Apply vector calculus operations and develop knowledge of vector fields and scalar fields. 2. Describe the fundamental nature of static fields, including steady current, static electric and magnetic fields. 3. Formulate potential problems within electrostatics, magnetostatics and stationary current distributions in linear, isotropic media, solve such problems in simple geometries using

separation of variables and the method of images and also Fluid equation of motion of charged particles in E and B field will be analysed

4. Apply Maxwell's equations and their application to time-harmonic fields, boundary conditions, wave equations, and Poynting's power-balance theorem.
5. Describe the properties of plane waves in unbounded space and understand such concepts as wavelength, phase velocity and attenuation.
6. Solve problems involving lossless transmission lines with time-harmonic excitation

Course Prepared By:	**Course Verified By:**
Dr. G. Shanmugavelayutham and Dr. Y.L. Jeyachandran	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – III	NUCLEAR AND PARTICLE PHYSICS	CORE - 9
18PHYC09	Teaching hours - 5 Hours / Week	Credits - 4

Objectives
To familiarize the students and to impart knowledge about basic nuclear physics properties, nuclear forces, single particle and collective picture of nucleus, nuclear decays and nuclear reactions, nuclear models for understanding of related reaction dynamics, instrumentation and applications, basic fundamental properties of elementary particles, symmetries and standard model so that they grasp the basics and are equipped with the techniques used for studying nuclear and particle physics.

Unit – I Properties of Nuclei

Constituents of the nucleus and Nomenclature: Proton – Electron model – Proton – Neutron model - Isotopes, Isobars, Isotones and mirror nuclei – Nuclear mass and binding energy – Unit of atomic mass – Mass defect and packing fraction – Binding fraction versus the mass number

***Nuclear Size& Properties*:**Nuclear radius - Estimation of nuclear radius – Mirror nuclei method – Scattering of fast electrons – Nuclear density– Nuclear Angular Momentum – Parity – Statistics – Magnetic dipole moment – Electric Quadrupole moment

***Nuclear force*:**Properties – The Deuteron bound state problem – Spin states of the two-nucleon system – Magnetic dipole moment and Electric quadrupole moment of deuteron – Low energy *n-p* scattering to understand nuclear force

Unit – II Nuclear Models

***Liquid drop model*:** Semi empirical mass formula – Applications of LDM - Mass parabola – Q-values (Alpha, Beta and Fission) – Energetics of fission – Fissility parameter - Bohr-Wheeler's theory

***Shell model*:**Evidences in favour of shell model - Shell model potential – Square well, Harmonic Oscillator, Woods-Saxon – Spin – Orbit coupling – Nuclear Ground state configuration and spin parity – Nuclear moment – Nuclear isomerism – Predictions and failures of the shell model

***Collective model*:** Vibrational model – Rotational model – Quadrupole moment – Fermi gas model

Unit – III Decay and Reactions

***Alpha decay*:** Energy relations - Q values –Spectrum and selection rules - Gamow's theory

Beta decay**:** Energy relations - Q values – Spectrum - Pauli's neutrino hypothesis – Electron capture – Fermi's theory of beta decay – Selection rules

Gamma decay – Kinematics of Gamma decay – Spectrum – Internal conversion – Selection rules

Nuclear Reactions – Types and conservation laws – Q–equation – Threshold energy – General solution of the Q equations – Cross section of nuclear reactions –Scattering and reaction cross section - Compound nucleus model – Breit Wigner single level formula – Ghosal's experiment

Unit – IV Instrumentation and Applications

Detectors: General Properties- Energy proportionality – Pulse shape – Energy resolution – Detection efficiency – Time resolution - Ionization Chamber – Geiger-Muller counter – Scintillation detectors – Semiconductor detectors

Accelerators –Linear Accelerator – Cyclotron – Large Hadron Collider

Applications – Neutron activation analysis – Rutherford backscattering spectrometry – Accelerator mass spectroscopy

Unit – V Particle Physics

Interactions– Strong – Electromagnetic – Weak – Gravitational

Constituent particles of matter– Leptons and Quarks – Classification of Particles – Baryon number – Isospin – Resonance Particles – Strangeness and Strange particles – Hypercharge – Charge conjugation – Time reversal – Parity - CPT Theorem – Eightfold Way – Baryon Octet – Meson octet – Hypercharge *vs* Isospin – Baryon de-couplet - Conservation laws – Ideas of Standard model and Higgs particle

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Introductory Nuclear Physics	K.S. Krane	Wiley India Ltd.	2008
2.	Nuclear Physics – Principles and Applications	John Lilley	Wiley India	2006
3.	Nuclear Physics	H.M. Agrawal	PHI Learning Private Limited	2016
4.	An introduction to Nuclear Physics	Y. Jana	Narosa	2015
5.	Nuclear Physics	V. Devanathan	Narosa	2012
6.	Physics of the nucleus	A.B. Gupta and H. Roy	Books and Allied (P)	2008

			Ltd.	
7.	Facts and mysteries in elementary particle physics	M. Veltman	World Scientific	2003
8.	Introduction to elementary particles	D. Griffiths	John Wiley & Sons	1987
9.	Particle Physics	B.R. Martin and G. Shaw	Wiley	1997

Tutorial: (This portion is not intended for examination purpose)

1. Estimate Q values of alpha decay using Weizacker mass formula
2. Calculate the most stable Z value of an isobaric family
3. Study the magnetic and quadrupole moment using shell model
4. Estimate the half-life of ^{235}U using WKB method
5. Prove that the Deuteron doesn't have excited sates

Learning Outcomes
After passing the course the student should be able to 1. Describe the basic nuclear properties, like size, density, moments, force 2. Describe the properties of strong and weak interaction. 3. Explain the different forms of radioactivity and account for their occurrence 4. Account for the fission process, shell structure, collective behavior 5. Calculate the kinematics of various nuclear reactions and decay processes 6. Account for the essential instrumentation for detection, acceleration 7. Explain the applications like activation analysis, backscattering spectrometry. 8. Classify elementary particles, associated symmetries, conservations, standard model

Course Prepared By:	**Course Verified By:**
Dr. M. Balasubramaniam and Dr. R. Shankar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – III	**THERMODYNAMICS AND STATISTICAL MECHANICS**	**ELECTIVE – 3 CHOICE - 1**
18PHYE03A	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives
• To provide a phenomenological introduction to thermodynamics through thermodynamics postulates, quantities and relations • Studying the micro and macroscopic properties of the mater through the statistical probability laws and distribution of particles • Understanding the classical and quantum distribution laws and their relations • Studying transport properties, different phases of maters, equilibrium and non-equilibrium process

Unit – I Thermodynamics, Microstates and Macrostates

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

Unit – II Microcanonical, Canonical and Grand canonical Ensembles

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

Unit – III Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann Distributions

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

Unit – IV Transport and non-equilibrium processes

Derivation of Boltzmann transport equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation – Transport processes; One speed and one dimension - All speeds and all directions - Conserved properties - Distribution of molecular velocities – Equipartition and Virial theorems - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Thermal conduction - The heat equation

Unit – V Heat capacities, Ising model, and Phase Transitions

Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas – Heat capacity of Bose gas –One-dimensional Ising model and its solution by variational method – Exact solution for one-dimensional Ising model - Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams for pure systems – Clausius-Clapeyron equation – Gibbs phase rule

Books for study and Reference:

No.	Title	Author	Publisher & Edition	Year
1.	An Introductory Course of Statistical Mechanics	P.B. Pal	Narosa Publishing House	2008
2.	An introduction to Thermodynamic and Statistical Mechanics	Keith Stowe	Cambridge University Press, 2nd Edition	2013
3.	Elements of Statistical Mechanics	Kamal Singh & S.P. Singh	S. Chand & Company	1999
4.	Statistical Mechanics An Elementary Outline	Avijit Lahiri	University Press, Hyderabad	2002
5.	Thermodynamic and Statistical Mechanics(Lecturers on the theoretical physics)	Arnold Sommerfeld	Levant Books, Kolkatta	2005

Tutorial: (This portion is not intended for semester examination)

1. Show explicitly that Gibbs paradox disappears when the correction is included.

2. Obtain free energy of the linear harmonic oscillator through thermodynamic quantities

3. Derive Helmholtz free energy in terms of T, H and N.

4. Find entropy, energy and heat capacity of a two level system when the temperature is zero and infinity.

5. Estimate the critical temperature for Bose condensation for ^{4}He atoms. Take g=1 and n=3X10^{22} cm^{-3}.

6. Calculate energy density and number density of massless Fermi gas at any temperature when chemical potential is equal to zero and chemical potential is equal to some arbitrary value

Learning Outcomes
After passing the course the student should be able to 1. Understanding of thermodynamic concepts, which are related to materials properties, various areas of research and development. 2. Fundamental understanding on relation between microscopic and macroscopic particles and their properties. 3. Knowledge on role of distribution of particles and energy within the available states on properties of the matter 4. Knowing the possible states of the mater and energy exchange during the change in state of the matter.

Course Prepared By:	**Course Verified By:**
Dr. K. Senthilkumar and Dr. R. Shankar	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – III	MATERIALS PHYSICS AND PROCESSING TECHNIQUES	ELECTIVE – 3 CHOICE - 2
18PHYE03B	Teaching hours - 5 Hours / Week	Credits - 4

Objectives
• To impart knowledge on various materials growth, synthesis and processing techniques • To learn the structural, morphology, and surface characterization techniques.

Unit – I Crystal growth

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

Unit – II Plasma processing

Basics of plasma: Introduction, Types of plasma; Properties of plasma; V-I characteristics;Advantages of plasma processing.Thermal plasma: Principles of plasma generation DC plasma torches; AC plasma torches;RF plasma torches, Plasma spraying; Structure of sprayed deposits, Plasma spheroidization;Plasma decomposition; Treatment of hazardous wastes – Synthesis of ultrafine/nanopowders. Plasma melting and remelting.Non-thermal plasma: Glow discharge plasma, Plasma reactors for surface treatment: Corona& DBD atmospheric pressure surface treatment reactors

Unit – III VacuumTechniques

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

Unit – IV Growth technique of thinfilms and nanomaterials

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

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

Unit-V Characterization Tools

Working principles and instrumentation – XRD – XPS – AES- SIMS - RBS– LEED - AFM – SEM - STM

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Handbook of Thin Film Technology	Maissel and Glange	McGraw Hill, First Edition	1970
2.	Vacuum Technology	A. Roth	North Holland, Third Edition	1990
3.	Fundamentals of Vacuum Techniques	Pipko A, Pliskosky V	MIR Publishers First Edition	1984
4.	Thin Films Phenomena	K. L. Chopra	McGraw Hill, First Edition	1969
5.	Ultra High Vacuum Technology	D. K. Avasthi, A. Tripathi, A. C. Gupta	Allied Publishers Private Limited	2002
6.	Thin Film Solar Cells	Kasturi Lal Chopra, Suhit Ranjan Das	Plenum Press, New York	1983
7.	Basic Vacuum Technology	A.Chambers, R.K.Fitch and B.S.Halliday	IOP Publishing Ltd 2ND Edition	1998
8.	Vacuum Technology	A.Roth	Elsevier Science 3rd Edition	1990
9.	Non-equilibrium processing of materials (Chapter – 6)	Edited by C. Suryanarayana	Pergamon	1999
10.	Thermal plasma processing	P.V. Ananthapadmanabhan and N. Venkataramani	Pergamon materails series Vol 2	1999
11.	Industrial plasma engineering - Applications to Nonthermal plasma processing (Vol. 2)	J. Reece Roth	Institute of Physics Publishing, Bristol	2001
12.	Thermal plasmas– Fundamentals and Applications (Vol. 1)	Maher I. Boulos, PierreFauchais and Emil Pfender	Springer Science, NY	1994
13.	Low temperature plasma physics	Edited by Rainer Hippler, Sigismund P fau, MartinSchmidt, Karl H. Schoenbach	Wiley-Vch, Berlin	2001

Learning Outcomes
1. At the end of this course, students can be able to prepare bulk crystals, thinfilms and nanomaterials. 2. Further, the student can able to analyse the properties of materials using various characterization tools.

Course Prepared By:	**Course Verified By:**
Dr. K. Srinivasan, Dr. D. Nataraj, Dr. R. Kalaiselvan and Dr. G. Shanmugavelayutham	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – I	**ADVANCED PHYSICS LAB**	**LAB - 3**
18PHYL03	**Teaching hours - 6 Hours / Week**	**Credits - 4**

Objectives

- To give hands on training to do advanced physics experiments
- To make the students understand the concepts behind various physics experiments such as polarizability of liquids, dispersive power of prism, refractive index of glass, ultrasonic wave velocity of liquids, young's modulus of materials etc.,
- To give exposure to measure some of the physical parameters with maximum accuracy.

No.	Experiment
1.	Determination of Young's modulus of glass by Cornus Method.
2.	Determination of Cauchy's constant and dispersive power of a given prism by measuring refractive index for different wavelengths.
3.	Determination of the polarizability of the given liquid by measuring the refractive index at different wavelengths.
4.	To prove the energy transferred from electrons to atoms always has discrete values by Frank hertz experiment.
5.	To calculate the Lande's splitting factor by using Electron Spin ResonanceSpectrometer.
6.	Determination of band gap and resistivity of semiconductor at different temperaturesby Four Probe Method.
7.	Determination of Hall coefficient, mobility, Hall angle and number of charge carriers by using Hall setup.
8.	Determination of the coercivity, retentivity and saturation magnetization of the given material using hysteresis loop tracer equipment.
9.	Determination of the velocity and compressibility of the given liquid using ultrasonic interferometer.
10.	Determination of the wavelength of given monochromatic source and the difference in wavelength of the two spectral lines D_1 and D_2 of Sodium source using Michelson Interferometer.

11.	Determination of wavelength of different lines in a Mercury spectrum and measurement of thickness of the mica sheet by Michelson Interferometer Experiment.
12.	To measure the ionizing radiation from the given source using GM counter experiment
13.	To study the characteristics of Klystron Tube and to determine its electronic tuning range.
14.	To determine the frequency & wavelength in a rectangular waveguide working on TE_{10} mode.
15.	Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne – Laser.
16.	Determination of Refractive index of liquids using He-Ne Laser / Diode Laser.
17.	Determination of Ultrasonic velocity in a given liquid for a fixed frequency.
18.	To study the characteristics of LDR (light dependent resistor) and photo voltaic cell.
19.	Determination of Young's modulus of glass plate by Elliptical fringe method.
20.	Determination of Young's modulus of glass plate by Hyperbolic fringe method.

Learning Outcomes

After passing the course the student should be able to

1. Understand the concepts behind various physics experiments.
2. Measure different physical parameters with maximum accuracy.
3. Determine various physical constants through different physics experiments.

Course Prepared By:	**Course Verified By:**
Dr. G. Shanmugavelayutham and Dr. Y.L. Jeyachandran	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – IV	MODERN OPTICS	CORE – 10
18PHYC10	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives
To enable the students to learn the concepts behind the various optical phenomena such as polarization, double refraction, lasers, fiber optics, non-linear optics, magneto-optics and electro-optics which are useful for various modern day-to-day applications.

Unit-I: Polarization and Double Refraction

Classification of Polarization; Transverse character of light waves; Polarizer and Analyzer; Production of polarized light: Wire grid polarizer and Polaroid, Polarization by Reflection, Polarization by Scattering; Malus law; Phenomenon of double refraction; Normal and Oblique Incidence - Interference of polarized light: Quarter and Half wave plates; Analysis of polarized light; Optical activity.

Unit-II: Lasers

Basic principles: Spontaneous and stimulated emissions; Components of the laser – Resonator and Lasing action, Types of Lasers and its applications: Solid State Lasers – Ruby laser, Nd:YAG laser; Gas lasers – He-Ne laser, CO_2 laser; Chemical lasers – HCl laser, DF-CO_2 laser; Semiconductor laser.

Unit-III: Fiber Optics

Total Internal Reflection; Optical Fiber; Glass fibers; Coherent bundle; Numerical aperture; Attenuation in Optical Fibers; Single mode and Multi-mode fibers; Pulse dispersion in multimode Optical Fibers: Ray dispersion in multimode step index Fibers; Parabolic-index Fibers; Fiber-Optic Sensors: Precision displacement sensor; Precision vibration sensor.

Unit-IV: Non-Linear Optics

Basic Principles; Harmonic Generation; Second Harmonic Generation; Phase Matching; Third Harmonic Generation; Optical Mixing; Parametric generation of light; Self-Focusing of Light.

Unit-V: Magneto-Optics and Electro-Optics

Magneto-Optical Effects: Zeeman effect; Inverse Zeeman effect; Faraday effect; Voigt effect; Cotton-Mouton effect; Kerr Magneto-Optic effect; Electro-Optical Effects: Stark effect; Inverse stark effect; Electric double refraction; Kerr Electro-Optic effect; Pockels Electro-Optic effect.

Books for Study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Optics	Ajoy Ghatak	McGraw-Hill Education Pvt Ltd, 6th edition	2017
2.	Lasers and Non-Linear Optics	B.B. Laud	New Age International (P) Ltd., 3rd Edition	2017
3.	Laser Fundamentals	William T. Silfvast	Cambridge University Press, New York	1996
4.	Fundamentals of Optics	F.A. Jenkins and H.E. White	McGraw-Hill International Edition, 4th Edition	1981
5.	Optics, Light and Lasers	Dieter Meschede	Wiley-VCH, Verley GmbH	2004
6.	Optical Physics	A. Lipson, S.G. Lipson, H. Lipson	Cambridge University Press, New Delhi, 4th Edition	2011

Tutorials:

1. A left circularly polarized beam (λ_0=5893 Å) is incident normally on a calcite crystal (with its optic axis cut parallel to the surface) of thickness 0.005141 mm. What will be the state of polarization of the emergent beam?
2. In a CO_2 laser ($\lambda_0 \approx 10.6$ µm) the laser transition occurs between the vibrational states of the CO_2molecule. At T ≈500 K, calculate the Doppler line width $\Delta\nu_D$ and $\Delta\lambda_D$ [$M_{CO2} \approx$ 44 M_H].
3. For a step-index multimode fiber, n_1=1.5 and Δ=0.015. Calculate n_2, NA and the maximum acceptance angle.
4. A 5 mW laser beam passes through a 26 km fiber of loss 0.2 dB/km. Calculate the power at the output end.
5. Consider a parabolic index multimode fiber with n_1 = 1.46, Δ = 0.01 operating at 850 nm with an LED of spectral width 20 nm. Calculate the intermodal dispersion, material dispersion and maximum bit rate.

Learning Outcomes
After passing the course the student should be able to 1. Understand the practical knowledge of usage of various optical components in modern devices and instruments. 2. Describe how the polarization is used to decrease glare by display screens. 3. Start the research work on application aspects of lasers. 4. Establish knowledge and an extensive understanding of lasers and non-linear optics. 5. Learn about the principles of magneto-optic and electro-optic effects and its applications.

Course Prepared By:	**Course Verified By:**
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SEMESTER – IV	**SEMICONDUCTOR DEVICES**	**CORE – 11**
18PHYC11	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives
Semiconducting materials and semiconductor devices play a very important role in modern technology. Semiconductor devices are not only indispensable parts of systems, such as computers, biomedical equipment, which are important in our daily life, but also from the basis for development of novel technology through their operational principles. Knowledge and understanding of semiconductors and devices are essential for applied physics graduates planning for a technological career. The aim of this course is to provide the students a sound understanding of semiconductor physics and the operational principles of some electronic devices, for learning and using modern technology. In this course, students can also develop the basic analytical skills required for learning or developing novel devices, their fabrication processes and technological applications for their future career

Unit I Semiconductor Physics-Energy bands and carrier transport phenomena:

Energy bands:Semiconductor Materials, Basic Crystal Structure, Basic Crystals Growth Technique, Valence Bonds, Energy Bands, Intrinsic Carrier Concentration, Fermi-Dirac distribution function, Donors and Acceptors, Non-degenerate Semiconductor; impurity doping: basic diffusion process, diffusion equation, diffusion profiles;

Carrier Transport Phenomena: Carrier Drift: mobility, resistivity, Hall Effect; Carrier Diffusion: diffusion process, Einstein Relation, current density equation; Generation and Recombination Processes: direct and indirect recombination, surface recombination, Auger recombination; Continuity Equation, The Haynes-Shockley Experiments; Thermionic Emission Process, Tunneling Process: i.e Schrodinger equation; High Field Effects

Unit II Semiconductor devices: p-n junction:

Basic Fabrication Steps: Oxidation, Lithography; Thermal Equilibrium Condition: Band Diagram, Equilibrium Fermi Level; Depletion Region: Abrupt junction, Linearly Graded junction; Depletion Capacitance, Current-Voltage Characteristics: generation-recombination and high-injection effects; Charge Storage and Transient Behaviour, Junction Breakdown: i.e tunneling effect;, Avalanche multiplication, Heterojunction;

Bipolar Transistor basics: Bipolar transistor Action: operation in the active mode; Static Characteristics of Bipolar Transistor; frequency response

Unit III Semiconductor devices:

MOSFET and Related Devices: The MOS Diode: i.e the ideal MOS diode, metal & semiconductor work function, the SiO2 -Si MOS diode, CCD; MOSFET fundamental: linear and saturation regions, types of MOSFET, threshold voltage control; MOSFET scaling: i.e short-channel effect, scaling rules; CMOS and BiCMOS: i.e Latch-up; MOSFET on insulator: i.e thin film transistor; MOS Memory structures: DRAM, SRAM, Nonvolatile memory; the power MOSFET;

MESFET and Related Devices: Metal-Semiconductor Contacts: i.e the Schottky barrier, semiconductor work function, Ohmic contact; MESFET: Devices structure, principles of operation, high-frequency performance;

MODFET: MODFET fundamentals

Unit IV Microwave Diodes, Quantum-Effect, and Hot-Electron Devices:

Basic Microwave Technology: i.e IEEE microwave frequency bands; Tunnel diode: i.e I-V characteristics; Impatt diode: i.e static & dynamic characteristics, field distributions and generated carrier densities; transferred-electron devices: i.e negative differential resistance, device operation; quantum-effect devices: i.e resonant tunneling diode, energy of electrons; hot-electron devices: i.e hot-electron HBT, real-space-transfer transistor

Unit V Photonic Devices:

Radiative Transitions & Optical Absorption: radiative transistor, Boltzman distribution, optical absorption, optical absorption coefficients; LED: visible LEDs, bandgap semiconductors, Snell’s law, orangic LED, Infrared LED ; Semiconductor Laser: laser operation, energy bandgap, carrier & optical confinement, optical cavity & feedback, basic laser structure, distributed feedback laser, quantum-well laser, energy of charge particle Photodetector: photoconductor, photodiode, quantum efficiency, response speed, p-i-n photodiode, heterojunction photodiode, avalanche photodiode) 4.5 Solar Cell: solar radiation, p-n junction solar cell, conversion efficiency, silicon & compound-semiconductor solar cells, optical concentration

Problems: Carrier concentration and Fermi level distribution related problems can be asked

Books for study and Reference

No.	Title	Author	Publisher & Edition	Year
1.	Semiconductor Devices Physics and Technology	S. M. Sze	Wiley Publication 2nd Edition	1985
2.	Physics of semiconductor devices	S.M. Sze and Kwok K. Ng	Wiley, Third Edition	2007
3.	Solid State Electronic Devices	B G Streetman, S Banerjee	Prentice Hall, 6th Edition	2009

4.	Semiconductor Physics and Devices: Basic Principles	D A Neamen	McGraw-Hill, 3rd Edition	2003

1. Measurement of Metal/ Semiconductor barrier height
2. Application of Possion's equation in Semiconductor devices
3. Depletion width calculations
4. Construction of equivalent circuits for devices like MOSFET, MESFET, JFET and determination of noise figure.

Learning Outcomes
At the end of this course the student must be able to 1. Describe the physical characteristics, such as electronic structures and optical and transport properties of semiconductors and I-V characteristics of semiconductor devices. 2. Relate the electronic structures of semiconductors to their atomic and crystal characteristics. 3. Relate the transport and optical properties of semiconductors to fundamental physics processes. 4. Apply fundamental principles and processes for operational semiconductor devices and their uses. 5. Describe and model some semiconductor properties, processes and device characteristics using equations. 6. Evaluate and analyze device characteristics in terms of the material properties and/or structural parameters.

Course Prepared By:	**Course Verified By:**
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SEMESTER – IV	ATOMIC PHYSICS AND MOLECULAR SPECTROSCOPY	CORE – 12
18PHYC12	**Teaching hours - 5 Hours / Week**	**Credits - 4**

Objectives
• To educate the students about the fundamental aspects of atomic and molecular spectroscopy. • To expose the students to various molecular and atomic spectroscopy techniques available to study the chemical and structural properties of materials.

Unit-I: Electronic spectroscopy of Atoms

Electronic wave function – atomic quantum numbers – hydrogen atom spectrum – Electronic angular momentum – Fine structure of hydrogen atom – Many-electron atoms – Lithium atom spectrum – angular momentum of many electron atoms – Term symbols – LS and JJ coupling – Spectrum of helium and alkaline earths – Equivalent and non-equivalent electrons – Zeeman effect – Paschen-Back effect – Stark effect – X-ray photoelectron spectroscopy.

Unit-II: Aspects of Molecular Spectroscopy and Rotational spectroscopy

Diatomic molecule – Molecular orbital theory (LCAO) – Shape of molecular orbitals (Morse Potential) – Born-Oppenheimer approximation – Regions of the electromagnetic spectrum – Width and intensity of spectral lines – Rotation of molecules – Rigid diatomic molecules – Intensity of line spectra – the effect of isotropic substitution – non-rigid rotator and their spectra – polyatomic molecules (linear and symmetric top molecules) – Technique and instrumentation of microwave spectroscopy.

Unit-III: Vibrational Spectroscopy

Energy of diatomic molecules – Simple Harmonic Oscillator – Anharmonic oscillator – Diatomic vibrating rotator – Vibration-Rotation spectrum of carbon monoxide – Breakdown of Born-Oppenheimer approximation –Vibrations and symmetry of polyatomic molecules – Influence of rotation on the spectra of polyatomic molecules (linear and symmetric top molecules) – Quantum and classical theory of Raman effect – pure rotational Raman spectra (linear and symmetric top molecules) – Raman active vibrations – Vibrational Raman spectra – Rotational fine structure – Vibrations of spherical tip molecules – Techniques and instrumentation of Infrared and Raman spectrometers.

Unit-IV: Electronic Spectroscopy of Molecules

Vibrational coarse structure progressions – Franck-Condon principle – Dissociation energy and their products – Rotational fine structure of vibronic transitions – Fortat Diagram – Pre-dissociation – Spectrum of molecular hydrogen – Change of shape on excitation – Chemical analysis by electronic spectroscopy – Re-emission of energy by an excited molecule.

Unit-V: Spin Resonance Spectroscopy

Nature of spinning particles – Spin and magnetic field interaction – Larmor precession – Relaxation time – Spin-spin relaxation – Spin–lattice relaxation - NMR chemical shift – Coupling constants – Coupling between nuclei – Chemical analysis by NMR – Exchange Phenomena - NMR for nuclei other than hydrogen - ESR spectroscopy – g-factor – Electron-Nucleus Coupling – Electron-Electron Coupling.

Books for study and reference

No.	Title	Author	Publisher & Edition	Year
1.	Fundamentals of Molecular Spectroscopy	Colin N. Banwell and Elaine M. McCash	McGraw-Hill Education (India) Pvt. Ltd, 5/e	2013
2.	Fundamentals of Molecular Spectroscopy	Walter S. Struve	John Wiley and Sons	1989
3.	Molecular structure and spectroscopy	G. Aruldhas	Prentice-Hall of India	2004
4.	Spectroscopy (Atomic and molecular)	G. R. Chatwal and S. K. Anand	Himalaya Publishing House, 5/e	2016

Learning Outcomes

At the end of this course the student must be able to

1. Identify the spectroscopic tools to investigate rotational, vibrational, electronic and structural characteristics of materials.
2. Understand the spectra, extract spectral signatures, interpret them and associate to different properties of materials.

Course Prepared By:	**Course Verified By:**
Dr. Y.L. Jeyachandran and Dr. G. Shanmugavelayutham	Chairman and Members, BOS - PG - Physics (UD)

SEMESTER – IV	**OPTICS AND LASER LAB**	**LAB - 4**
18PHYL04	**Teaching hours - 6 Hours / Week**	**Credits - 4**

Objectives

- To provide hands on training to the students to use the He-Ne laser source.
- To train the students to do experiments in order to understand the characteristics of lasers.
- To provide opportunity for the students to understand the phenomena behind the various interferometry methods.
- To train the students to determine various physical parameters of particles, thin wires, optical fibres using laser source.

No.	Experiment
1.	Determination of numerical aperture of an optical fiber by using He-Ne Laser.
2.	Determination of wavelength of alaser source using diffraction grating.
3.	Determination of diameter of the given thin wire by diffraction method usingHe-Ne-Laser.
4.	Determination of diameter of the given pinhole using He-Ne laser.
5.	Determination of the width of thegiven single slit by diffraction of light using He-Ne Laser.
6.	Determination of particle sizeof the given powder sample using He-Ne laser.
7.	Determination of least count of the given meter scale using He-Ne laser.
8.	Determination of the beam-spot size using He-Ne laser.
9.	Determination of focal length of a given lens using He-Ne laser.
10.	Measurement of the divergence of a laser beam.
11.	Determination of the polarization of light and verification of Malu’s law using He-Ne laser.
12.	Determination of wavelength of a laser by Michelson Interferometer method.

13.	Determination of thickness of the sleeve on a fine wire using He-Ne laser.
14.	To study the Magneto-optic effect of the given sample using He-Ne laser source.
15.	To study the magneto-optic rotation (Faraday effect) with He-Ne laser source.
16.	Direct reading of Zeeman effect (e/m of an electron) with a laser source.
17.	Demonstration of fringes of constant thickness using Fabry-Perot Interferometer.
18.	Testing of given optical components using Twyman-Green Interferometer.
19.	Measurement of refractive index of gas by Rayleigh Interferometer.
20.	Recording of a hologram and reconstruction of the image using Holography set-up.

Learning Outcomes

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

- Handle He-Ne laser sources effectively for performing experiments to measure different physical parameters of thin wires, particles, optical fibres etc.,
- Use different interferometers for measuring refractive index of gas, optical components testing and making fringes for constant surface.
- Understand the concepts behind the generation of hologram.

Course Prepared By:	**Course Verified By:**
Dr. K. Srinivasan and Dr. K. Suresh	Chairman and Members, BOS - PG - Physics (UD)

Supportive Courses – Offered to students from other Departments

ODD SEMESTER	BASIC ELECTRONICS	SUPPORTIVE – 01
18PHYS01	Teaching hours - 2 Hours / Week	Credits - 2

Objectives
• To expose the students widely used electrical and electronics components • To teach the students about the amplifiers and logic circuits

Unit- I: Review of Electric Circuits and Semiconductor Devices

Kirchoff's laws-resistors-capacitors-inductors-Thevnin's theorem-Norton's theorem-Maximum power transfer theorem - Semiconductors- pn diode- Zener diode- Varactor diode-PIN diode- Photovoltaic cell-Light Emitting Diode- Bipolar Junction Transistor(BJT)

Unit-II : Amplifiers And Digital Logic Circuits

BJT amplifiers-CE, CB and CC configuration – Operational Amplifiers- Ideal Op.amp – Inverting and non-inverting op amp circuits-Summing and difference amplifier - Boolean laws and theorems-Logic Gates: AND, OR, NOT, EX-OR, EX-NOR, NAND & NOR - Logic Gates using Discrete Components- NAND &NOR as Universal Gates- Half Adder and Full Adder-Half and Full subtractor- De Morgan's theorems

Books for Study and Reference

1. Electronics: circuits and systems-Swaminathan Madhu, Howard W. Sams& Co, Inc - First Edition-(1985)
2. A Text book of Applied Electronics- R.S.Sedha , S.Chand &Company , 3rd Edition (2008)
3. Digital principles and applications-A.P Malvino and D.P Leach , Sixth Edition, Tata McGraw-Hill, New Delhi(2006)

Learning Outcomes
• Understand how electronic components are working and where they can be used. • Understand which kind of communication they are practiced in day today life.

Course Prepared By:	Course Verified By:
Dr. P. Christopherselvin and Dr. R. Shankar	Chairman and Members, BOS - PG - Physics (UD)

EVEN SEMESTER	ENERGY RESOURCES	SUPPORTIVE – 02
18PHYS02	**Teaching hours - 2 Hours / Week**	**Credits – 2**

Objectives
• To bring awareness to the students on various renewable non-renewable energy resources • To bring knowledge to the students on energy utilization and conservation

Unit I

Renewable and non-renewable Energy Sources, Earth's Energy Budget, Solar radiation at the Earths surfaces, Instruments for measuring Solar Radiation, Applications of Solar Energy, Solar cell (Photovoltaic conversion) - Types, Principle and Working-Efficiency- Characteristics, Advantages, Disadvantage and Applications ofSolar Cells.

Unit II

Solar Energy-Flat Plate Collector, Solar Air Heater, Water Heater, Cooker, **Wind Energy-**Wind Energy Conversion, Advantages and Disadvantages of Wind Energy Conversion,
Energy from Bio-mass and Bio-gas-Sketch diagram-Production and application of Bio- gas,
Ocean Thermal Energy-Principle of Working, Tidal and wave energy, Geothermal energy,
Nuclear Energy-Nuclear reactors and its applications,
Energy Storage-Electrical Storage, Chemical Storage,
Fuel Cell-Principle, Types and Working Applications.

Learning Outcomes
At the end of the course students get to know about • Various energy resources and their effective utilization. • The mechanism and production of different forms of energy.

Books for Study and Reference

1. Nonconventional energy Sources-GD. Rai, Khanna Publication, (2004), New Delhi.
2. Modern Physics, R. Murugeshan, S. Chand & Co Ltd, (1999), New Delhi.
3. Allied and Applied Physics, John Suja, (1995), India.

Course Prepared By:	**Course Verified By:**
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