ANNAMALAI UNIVERSITY

403 - M. Sc. PHYSICS

Programme Structure and Scheme of Examination (under CBCS)
(Applicable to the candidates admitted in Affiliated Colleges
from the Academic year 2022 -2023 onwards)

Course Code	Study Components & Course Title	Hours /Week	Credit	Maximum Marks		
				CIA	ESE	Total
	SEMESTER – I					
22PPHYC11	Core Course - I: Classical and Relativistic Mechanics	5	4	25	75	100
22PPHYC12	Core Course – II: Mathematical Physics -I	5	4	25	75	100
22PPHYC13	Core Course – III: Electronics	5	4	25	75	100
22PPHYC14	Core Practical – I	8	4	40	60	100
22PPHYE15	Core Elective – I	4	4	25	75	100
22PPHYO16	Open Elective – I	3	3	25	75	100
	Total	**30**	**23**			**600**
	SEMESTER – II					
22PPHYC21	Core Course - IV: Quantum Mechanics	5	4	25	75	100
22PPHYC22	Core Course – V: Mathematical Physics - II	5	4	25	75	100
22PPHYC23	Core Course – VI: Thermodynamics and Statistical Mechanics	5	4	25	75	100
22PPHYP24	Core Practical – II	8	4	40	60	100
22PPHYE25	Core Elective – II	5	4	25	75	100
22PHUMR27	Compulsory Course : Human Rights	2	2	25	75	100
	Total	**30**	**22**			**600**

CORE ELECTIVE COURSES
(Choose 1 out 3 in each Semester)

SEMESTER	COURSE CODE	COURSE TITLE	H/W	C	CIA	ESE	TOTAL
I	22PPHYE15-1	Numerical Methods and Python programming	4	4	25	75	100
	22PPHYE15-2	Solar Energy Utilization	4	4	25	75	100
	22PPHYE15-3	Laser Physics and Non Linear Optics	4	4	25	75	100
II	22PPHYE25-1	Nano Science and Nano Technology	5	4	25	75	100
	22PPHYE25-2	Petro Physics	5	4	25	75	100
	22PPHYE25-3	Communication Electronics	5	4	25	75	100

OPEN ELECTIVE COURSES
For the Students of Other Departments
(Choose 1 out 3 in each semester)

SEMESTER	COURSE CODE	COURSE TITLE	H/W	C	CIA	ESE	TOTAL
I	22PPHYO16-1	Communication Physics	3	3	25	75	100
	22PPHYO16-2	Spectroscopy and Lasers	3	3	25	75	100
	22PPHYO16-3	Basis of Renewable Energy Sources	3	3	25	75	100

SEMESTER: I PART : Core Course	22PPHYC11: CLASSICAL AND RELATIVISTIC MECHANICS	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

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

Unit 1: Lagrangian And Hamiltonian Formalisms

Lagrangian formalism: Constrains – classifications – Degrees of freedom – Generalized coordinates – Configuration Space – D-Alembert's principle-Lagrange's equation from D-Alembert's principle- Applications: Double pendulum, Spherical pendulum, Cylinder rolling down an inclined plane.

Hamiltonian Formalism: Hamilton's equations of motion - Physical significance – Hamilton's variational Principle – Hamilton's equation of motion from variational principle – Integrals of Hamilton's equation – Principle of least action – Applications: Linear harmonic oscillator and projectile in space.

Unit 2: Rigid Body Dynamics And Canonical Transformations

Rigid body motion: Angular momentum and rotational kinetic Energy – Euler's angles –Euler's geometrical equations – Euler's equations of motion – Moment of inertia of rigid body Torque-free motion of a rigid body - Motion of a symmetrical top under the action of gravity.

Canonical transformations: Generating function – Condition for a function to be canonical –simple example – Poisson's brackets – Properties – Hamilton's equation of motion in Poisson's bracket-invariance of Poisson's bracket under canonical transformation – Lagrange brackets –properties.

Unit 3 : Central Force Motion And Hamilton - Jacobi Theory

Central Force motion: Reduction of one-body problem – Kepler's law – inverse square law force – Satellite parameters – Communication satellites – Scattering in a central force field –Orbits of artificial satellites.

Hamilton-Jacobi Theory: Hamilton – Jacobi equation Hamilton's characteristic function - Harmonic oscillator in the H-J method – Separation of variables – Action-angle variables – Harmonic oscillator in Action - Angle variables – Kepler's problem in Action-angle variables – Road to Quantization.

Unit 4: Oscillations And Nonliner Dynamics

Oscillatory motion: Theory of small oscillations – Normal modes – Normal co-ordinates – Linear triatomic molecule – Stability of Oscillatory motion - Forced Harmonic Oscillator.

Nonlinear Dynamics: Linear and Nonlinear systems – Pendulum equation – Phase portrait of the pendulum – Linear stability analysis – Fixed point analysis of Damped oscillator – Classical Chaos – Bifurcation – Logistic map – Universality of Chaos – Fractals – Routes to Chaos.

Unit 5 : Relativistic Mechanics

Theory of relativity: Postulates of special theory of relativity – Lorentz transformation - length Contraction – time dilation - Relativity of simultaneity - addition of velocities - variation of mass with velocity– Mass energy relation – Relativistic Lagrangian and Hamiltonian for a particle, Space - time diagram – Minkowski four dimension space – Principle of covariance – Four vectors in Mechanics

COURSE OUTCOMES

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

1. Have depth knowledge about Lagrangian and Hamiltonian formulations and solve problems using those formulations.
2. Have knowledge about fundamentals of rigid body motion and explain Moment of inertia tensor and Euler's equations of motion and will also be able to solve problems on force free motion of a rigid body and symmetrical top.
3. Apply Hamilton's characteristic function to solve problems. Understand Action Angle variables and solve one degree of freedom and Kepler's problem.
4. Acquire knowledge about oscillatory motion and stability of oscillatory motion. Understand the linear and nonlinear systems and basics of Chaos.
5. Understand the applications relativistic mechanics and its consequences.

Text books

1. G. Aruldhas, *Classical Mechanics* - PHI Learning Private Limited, New Delhi. (2015).
2. H. Goldstein, C. Poole and J. Safko, *Classical Mechanics* - Pearson Education Asia New Delhi, Third Edition. (2002).
3. S. L. Gutpa, V. Kumar and H.V. Sharma, PragatiPrakashan, *Classical Mechanics* - Meerut. (2016)
4. M. Lakshmanan, and S.Rajasekar, *Nonlinear Dynamics - Integrability, Chaos and Patterns,*Springer, (2003).

Supplementary Readings

1. S.N. Biswas, *Classical Mechanics*, Books and Allied Ltd., Kolkata. (1998).
2. Upadhyaya, *Classical Mechanics,* Himalaya Publishing Co., New Delhi. (1999)
3. L.D. Landau and E.M. Lifshitz, *Mechanics,*Pergomon Press, Oxford. (1969).
4. J.L. Synge and B.A Griffith, *Principles of Classical Mechanics*Mc.Graw-Hill, NewYork. (1949).

5. R.G.Takwale and P.S.Puranik, *Introduction to Classical Mechanics,* Tata McGraw Hill, New Delhi. (1989).

OUTCOME MAPPING

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

SEMESTER: I PART : Core Course	COURSE CODE: 22PPHYC12 TITLE : MATHEMATICAL PHYSICS – I	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1. To introduce the students the concepts of vector analysis and its uses.
2. To make the students to understand matrices and applications.
3. To make the student to study the aspect of tensor analysis.
4. To involve the student to learn special functions.
5. To educate the students in understanding group theory.

UNIT 1: Vector analysis

Integration of vector – Line, Surface, Volume Integrals - Gauss Divergence Theorem -Gauss Theorem - plane and vector form - Green's formula - Poisson's, Laplace's equation with its solution - Stokes 'Theorem in space. Curvilinear Co-ordinates - Orthogonal curvilinear coordinates - Condition for Orthogonality - Expression for gradient, divergence, curl and Laplacian coordinates - Cylindrical and Spherical co-ordinates - Problems.

UNIT 2: Matrices and applications

Special Matrices with their Properties – Rank of Matrix – Characteristic Matrix and Characteristic equation of a matrix – Transformations – Hermitian forms - Characteristic roots and vector of a matrix – Diagonalization of matrices. Applications – Theorems of rank of matrix – Solution of linear equations – Nature of Diagonalizing Matrices for Special Matrices – Power of Square Matrix – Exponential of Matrix - Problems.

UNIT 3: Tensor analysis

Introduction – Tensor as classification of transformation laws – rank of tensor – Symmetric and Anti symmetric tensors-Invariant Tensors- Inner and outer product – Contraction of a tensor – Quotient Law - Raising and lowering of suffixes – Metric tensor – Conjugate tensors – Christoffel symbols of first and second kind – Equation of a geodesic - Covariant derivatives.

UNIT 4: Special functions

Gamma, Beta Function - Value of $\Gamma(1/2)$ - other forms of Beta Function – Relationship between Beta and Gamma Functions-Reduction & Evaluation of Gamma Function – Contour integral for gamma functions - Derivation of Gamma Function – Stirling's Formula - Wallis's Formula - Incomplete Beta and Gamma Function - Meaning of Asymptotic series-Elliptic Integrals Problems.

UNIT 5 : Group thorey

Definition - Subgroups - Cyclic groups and abelian groups - Homomorphism and isomorphism of groups - Classes – Group of Isometries-Symmetry operations and symmetry elements -Representations of groups - Reducible and irreducible representations - Character tables for simple molecular types (C2v and C3v point group molecules).

COURSE OUTCOMES

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

1. Solve problems using Vector calculus method.
2. Apply matrices to solve higher level problems in quantum and statistical mechanics.
3. Solve problems using Tensor method.
4. Evaluate problems using Special function
5. Evaluate problems using group theory

Textbooks

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

Supplement Readings

1. R.K.Gupta& H.C. Sharma – *Mathematical Physics*, MeenakshiPrakashan Meerut (1999)
2. A.B. Gupta – *Fundamentals of Mathematical Physics,* Books and Allied (P) Ltd, Kolkata. 3rd Edition (2010).
3. Albert Cotton – *Chemical Applications of Group Theory* – Wiley Eastern Ltd., (1971).

OUTCOME MAPPING

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

SEMESTER : I PART: Core Course	COURSE CODE: 22PPHYC13 TITLE : ELECTRONICS	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1) To understand the working of semiconductor devices and diodes.
2) To educate the various types of semiconductor memories.
3) To study the importance and applications of operational amplifier.
4) To know about the basics of IC fabrication and applications of timer IC – 555.
5) To learn basics idea about the nanoelectronics.

UNIT 1 : Special semiconductor devices

Principle, construction, characteristics, working and uses of - Varactor diode - Schottky diode - Tunnel diode - Gunn diode - Optoelectronic diodes - LASER diode, LED and photo diode - photo transistor, LDR and solar cell.

UNIT 2: Semiconductor memories

Classification of memories and sequential memory – Static Shift Register and Dynamic Shift Register, ROM, PROM and EPROM principle and operation Read & Write memory - Static RAM, dynamic RAM, Content Addressable Memory - principle, block diagram and operation.- Programmable Logic Array (PLA) - Operation, Internal Architecture. Charge Couple Device (CCD) - Principle, Construction, Working and Data transfer mechanism.

UNIT 3: Operational amplifieras filters and oscillators

Operational amplifier -op-amp as comparator - Voltage to current and current to voltage conversions-active filters : low-pass, high pass, band pass, notch and rejection filter - Wien bridge and phase shift oscillator-triangular, saw-tooth and square wave generators-Schmitt's trigger - Voltage control oscillator - phase locked loops.

UNIT 4: IC Circuits AND IC Timer

Basic monolithic ICs - epitaxial growth - masking – etching- impurity diffusion –fabricating monolithic resistors, diodes, transistors, capacitors and inductor - circuit layout – contacts and inter connections – logic families – RTL, TTL, CMOS - 555 timer - description of the functional diagram - mono stable operation - applications of mono stable – bistable operation - astable operation - pulse generation - Schmitt's trigger

UNIT 5: Nanoelectronics

Physical properties of nanoscale electronics materials – energy subbands – density of states in quantum wire – ballistic transport – silicon nano transistors – carbon nanotubes for nano devices – CNT transistor – high electron mobility transistor using heterojunction – nano electromechanical systems – quantum dot cellular autoomata.

COURSE OUTCOMES

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

1) Understand the principles, working of semiconductor devices and diodes.
2) Study the various classifications and applications of semiconductor memories
3) Study the applications of operational amplifier.
4) Highlight the concept of IC circuits and IC 555 timer.
5) Understand basics idea about the nanoelectronics.

Text books:

1) Satnam P.Mathur, Electronic Devices - *Applications and Integrated Circuits,* John Wiley and Sons. (1986).
2) V.K.Mehta, *Principles of Electronics*- 6th Revised Edition,S.Chand and Company. (2001).
3) J. Millman, C. Halkias and C.D. Parikh, *Integrated Electronics, Analog and Digital Circuits and Systems* TMGH. (2010).
4) D. C. Dube, *Electronics circuits and analysis* – 2nd Edition, Narosa (2013).
5) Bhotkar , *Integrated Circuits*. Khanna Publishers , (2010).
6) B.L.Theraja , *BasicElectronic*, S.Chand& company ltd(2007)
7) Gupta and Kumar, *Handbook of Electronics*- Pragati Prakashan-34th edition (2007).
8) D.Chattopadhyay and P.C. Rakshit, *Electronics-Fundamentals and Applications*, New Age International Publications, New Delhi. (2010).
9) R.F. Coughlin and F.F, Driscol, *Op-Amp and linear integrated circuits*, Prentice Hall of India, New Delhi. (1996).
10) Ramakant A. Gayakwad, *Op-Amps and Linear Integrated Circits*, Pearson Education: Fourth Edition. (2015).

Supplementary Readings:

1) T.F. Schubert and E.M.Kim, "*Active and Nonlinear Electronics*", John Wiley Sons, New York. (1996)
2) L.FIoyd, Electronic Devices, "*Pearson Education*" New York. (2004)
3) Mottershed*, Semiconductor Devices and Applications*, Prentice Hall India Learning Private Limited.(1979)
4) Ben.G.Streefman, *Solid state electronic devices*, Printice Hall, Englewood Cliffs, NJ. (1999).
5) Albert Malvinoand DavidJ Bates, *Electronic Principles*- 7 th Edition, McGraw Hill. (2007).
6) David A. Bell ,*Electronic Devices and Circuits*, 4th Edition, Prentice Hall. (2007).
7) L. Floyd, *Electronic Devices,* Pearson Education, New York. (2004).
8) R.A. Gayakwad, *Op-Amps & Linear Integrated Circuits*,Printice Hall, New Delhi. (1999).
9) D. Roy Choudhury and S.B. Jain, *Linear Integrated Circuit*, New Age International Publications, New Delhi. (2010).
10) R.P.Jain, *Modern Digital Electronics,* Tata McGraw Hill. (1991).

11) Jacob Millman and Halkias, *Integrated Electronics,* McGraw Hill. (1972).

OUTCOME MAPPING

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

SEMESTER: I PART : Core Practical	COURSE CODE: 22PPHYP14 TITLE : PRACTICAL – 1 GENERAL & ELECTRONICS-I	CREDITS : 4 Hours/Week : 8

COURSE OBJECTIVES

1. To make the students to understand experimental physics
2. To apply the theoretical knowledge for developing new devices
3. To study the aspects related to the application side of the experiments
4. To understand the usage of basic laws and theories to determine various properties of the materials given

List of Experiments (Any 15 out of the given 22)

GENERAL EXPERIMENTS - I (Choose Minimum 6 experiments)

1. Young's modulus - Cornu's method – forming elliptical fringes.
2. Young's modulus - Cornu's method – forming hyperbolic fringes.
3. Spectrometer - Polarizability of liquids.
4. Spectrometer - Biprism - Wavelength of sodium light - Refractive Index of a liquid.
5. Hydrogen spectrum - Rydberg's constant.
6. Solar spectrum - Hartmann's Interpolation formula.
7. Co-efficient of linear expansion - Air wedge method.
8. Determination of specific rotatory power of liquid using polarimeter.
9. Forbe's method of determining thermal conductivity.
10. Identification of prominent lines by spectrum photography – Iron spectrum.

ELECTRONICS EXPERIMENTS- I (Choose Minimum 6 experiments)

1. Construction of dual regulated power supply.
2. V-I characteristics of solar cell.
3. OP-AMP-Active 2^{nd} order filter circuits : Low pass, High pass and Band pass filters.
4. OP-AMP- Design of Phase-shift Oscillator-Study of attenuation characteristics
5. OP-AMP- Design of Wien Bridge Oscillator-Study of attenuation characteristics.
6. OP-AMP - Solving simultaneous equations.
7. OP-AMP - Design of square wave, saw tooth wave, and Triangular wave generators.
8. OP-AMP - Design of Schmitt Trigger and construction of Monostablemultivibrator.
9. OP-AMP- Instrumentation amplifier
10. OP-AMP- Design of Pulse with modulator
11. Characteristics of a silicon controlled rectifier (SCR) and firing angle control

12. Characteristics of a unijunction transistor (UJT) and UJT as a relaxation oscillator.

COURSE OUTCOMES

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

1. Apply knowledge of Physics fundamentals and instrumentation to arrive solution for various problems.
2. Understand the usage of basic laws and theories to determine various properties of the materials given.
3. Understand the application side of the experiments
4. Acquire in depth knowledge regarding the basic concepts in electronics.
5. Apply theoretical knowledge to establish electronic experiments.

Text books

1. C.C. Ouseph, U.J. Rao, V. Vijayendran, *Practical Physics and Electronics*, Ananda Book Depot, Chennai. (2018).
2. M.N.Srinivasan, S. Balasubramanian, R.Ranganathan, *A Text Book of Practical Physics*, Sultan Chand & Sons, New Delhi. (2015).

Supplementary readings

1. Samir Kumar Ghosh, *A Textbook of Advanced Practical Physics*, NCBA, Kolkatta. (2000)
2. D. Chattopadyay, P.C.Rakshit, *An Advanced Course in Practical Physics,* NCBA, Kolkatta. (2011).

OUTCOME MAPPING

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

SEMESTER: I PART : Core Elective	COURSE CODE: 22PPHYE15 - 1 TITLE: NUMERICAL METHODS AND PYTHON PROGRAMMING	CREDITS : 4 Hours/Week : 4

COURSE OBJECTIVES

1. To educate the students in understanding Numerical solution of algebraic, transcendental and Simultaneous linear algebraic equations.
2. To make the students to understand Numerical Interpolation.
3. To educate the students in understanding Numerical Differentiation, Integration and Solutions of ordinary differential equations.
4. To involve the student to learn python fundamentals.
5. To involve the student to learn File management and Data Management in python tools.

UNIT 1: Numerical solution of algebraic, transcendental and simultaneous linear algebraic equations

Iteration method – The method of false position - Newton-Raphson method - Convergence and rate of convergence - Gauss elimination method – Jordon's modification – Gauss – Seidel method of iteration.

UNIT 2: Interpolation

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

UNIT 3: Numerical differentiation, integration and solutions of ordinary differential equations

Newton's forward and backward difference formula to compute derivatives – Numerical integration : Trapezoidal rule, Simpson's rule – Extended Simpson's rule – Euler's method – Improved Euler's method – Runge - Kutta method – second and fourth order – Runge - Kutta method for solving first order differential equations.

UNIT 4: Python fundamentals

Building object type : operator basics, numbers, strings, lists, Tuples, working with sequences, dictionaries, files, object storage, type conversion, type comparisons, statements : statement format, comments, assignments, print, control statements, common traps – example - Functions, Arguments, Importing a modules-python's built in functions – example.

UNIT 5 : Python programming

File processing - Reading-Writing to a file - Changing Position - Controlling file I/O - File Control - I/O Control - File Locking-Getting File list - Basic File/Directory Management - Access and Ownership - Checking Access - Getting File Information-Setting File Permissions -Manipulating File Paths-Managing Internal Structures - Sorting Sequences - Coping Objects -Objects Persistence - Object Storage - DBM Database - Commercial Database.

COURSE OUTCOMES

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

1. Solve problems using Numerical solution of algebraic, transcendental and Simultaneous linear algebraic equations.
2. Solve problems using Interpolation.
3. Evaluate problems using Numerical Differentiation, Integration and Solutions of ordinary differential equations.
4. Represent Python tool in different formats.
5. Apply Python tool in File and Data management.

Text books

1. Dr.M.K.Venekataraman, *Numerical methods in Science and Engineering.* The National Publishing Company Madras (1996).
2. Martin C. Brow- *The Complete Reference Python-* McGrawHill –(2018)

Supplementary reading

1. S.S. Sastry, *Introductory Methods of Numerical analysis*. Prentice – Hall of India, New Delhi (2003) 3rd Edition.
2. Mark Lutz, *Learning Python: Powerful Object-Oriented Programming*, 5th edition O'REILLY (2013).
3. Charles R. Severance, *Python for Everybody: Exploring Data Using Python 3*, Elliott Hauser, Sue Blumenberg (2016).

OUTCOME MAPPING

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

SEMESTER: I PART : Core Elective	COURSE CODE: 22PPHYE15 - 2 TITLE : SOLAR ENERGY UTILIZATION	CREDITS : 4 Hours/Week : 4

COURSE OBJECTIVES

1. Understand basic characteristics of Solar Energy and Technologies.
2. Learn the design and importance of Solar Energy Collectors for Solar energy utilization.
3. Use the testing methods to analyze various solar energy collectors.
4. Understand different types of energy storage devices and its uses.
5. Learn and use the concepts of Solar thermal and Photovoltaic power generation.

UNIT 1: Solar radiation analysis

Solar radiation outside the Earth's atmosphere - Solar radiation at the earth surface – Basic Terms and Earth Sun angles – Determination of Solar time – Equation of time - Derived solar angles - Solar day length – Measurement of Solar energy radiation - Pyrheliometer – Pyranometer - Sunshine recorder - Estimation of Direct and Diffused radiation - Total solar radiation on horizontal and tilted surfaces**.**

UNIT 2: Solar energy collectors

Physical Principles of the Conversion of Solar radiation into heat - Description of Flat Plate Collector (FPC) - Liquid heating type FPC - Energy balance Equation and Collector efficiency - General Characteristics of FPC – Thermal analysis of FPC and Useful heat gained by the fluid – Fin efficiency - Types of Air heaters – Performance of Solar Air heaters – Efficiency.

UNIT 3: Performance testing of solar collectors and storage

Governing Performance Equations – Measuring Instruments and Measurement Methods – Testing Procedure – Testing of Liquid Flat plate Solar collector and Solar Air collector – Storage of Solar Energy – Thermal Storage – Electrical storage – Storage in the form of Fuel – Hydro storage.

UNIT 4: Solar thermal power generation

Introduction – Principle of Solar thermal power generation – Low temperature systems – Medium temperature systems with concentrating collectors – Stirling cycle and Brayton cycle Solar thermal power generation – Tower concept of power generation –Total energy systems – selective coatings – Cost effectiveness.

UNIT 5: Solar electric power generation

Semiconductor principles – Photo Voltaic principles – Power output and Conversion efficiency – Basic Photovoltaic system for power generation – solar cell modules – advantages and disadvantages of Photo - Voltaic Solar energy conversion – Solar cell modules – Types of Solar Cells - Solar Cell construction – Design of Photovoltaic systems.

COURSE OUTCOMES

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

1. Understand the characteristics of solar radiation.
2. Gain knowledge in measuring the availability of solar radiation at a given location
3. Realize the role of solar collectors for effective solar energy utilization
4. Explain with the essentials of Solar thermal power generation
5. Familiarize with Photovoltaic method of Solar energy conversion into power.

Text books

1. G.D.Rai, *Solar Energy Utilization*, Khanna Publishers, Fifth edition. (2001).
2. S.P. Sukhatme, *Solar energy – Principles of Thermal Collection & Storage*, Tata McGraw Hill, Delhi. (1999).
3. Peter J. Lunde, *Solar Thermal engineering*, John Wiley New York. (1980).

Supplementary reading

1. Chetan Singh Solanki, *Solar Photovoltaics - Fundamentals, Technologies and Applications,* PHI Learning Pvt. Ltd., 3rd edition. (2015).
2. Garg .H.P, Prakash .J, *Solar Energy Fundamentals and Applications,* Tata McGraw-Hill. (2005).
3. Foster .R, Ghassemi M., Cota A., *Solar Energy*, CRC Press, (2010).

OUTCOME MAPPING

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

SEMESTER: I PART : Core Elective	COURSE CODE: 22PPHYE15 – 3 TITLE : LASER PHYSICS AND NON LINEAR OPTICS5	CREDITS : 4 Hours/Week : 4

COURSE OBJECTIVES

1. To understand the basic theory of laser action and the concept of Q-switching
2. To explain illustrate the working of various advanced Lasers available
3. To describe the basic Physics of nonlinear optics and demonstrate different NLO phenomena
4. To understand the Multiphoton process
5. To learn the vitals Fiber Optics.

UNIT 1 : Basic principles of lasers

Einstein's quantum theory of radiation - Population inversion – Laser Pumping - Issues in designing a laser - Pumping mechanisms - Resonators – Vibrational modes of resonator – Open resonator - Losses inside Cavity – Q-switching - Mode locking - Laser amplification - Frequency conversion.

UNIT 2 : Laser systems:

Basics of tunable - ultrafast and power lasers - Gas Lasers : He-Ne - He-Cd – Ar - Kr ion – CO_2 - Solid state lasers : Ruby - Nd-YAG - Fibre lasers - Liquid laser : Dye laser – Liquid $Eu3^+$ laser – Semiconductor laser - Quantum cascade lasers - p-Ge lasers, Vertical - cavity – surface - emitting laser.

UNIT 3: Introduction to nonlinear optics:

Origin of nonlinearity - Polarization – Anisotropic media - Light propagation through anisotropic media – Nonlinear polarization – Nonlinear susceptibility - Wave equation - Second harmonic generation (SHG) - Phase matching - Parametric amplification - Sum and Difference frequency generation - Parametric oscillation.

UNIT 4: Multiphoton process:

Third harmonic generation (THG) - Two photon process – Experiment evidences of 2PA materials – Multi and Three photon process - Electro-optic Shutter (Kerr effect and Pockels effect) - Self-focusing – Spontaneous and Stimulated Raman Scattering, Hyper - Raman effect - Higher-order Raman processes - Photorefractive effect.

UNIT 5: Fiber optics

Step – Graded index fibres – Wave propagation – Fiber modes – Single and multimode fibres –Numerical aperture – Dispersion – Fiber bandwidth – Fiber losses - Scattering, absorption, bending, leaky mode and mode coupling losses – Attenuation coefficient - Material absorption.

COURSE OUTCOME

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

1. Explain the fundamental theory of laser actions
2. Brief out the various concepts of advanced laser systems
3. Describe the elementary ideas of nonlinear optics
4. Elaborate the utilization of NLO phenomenon in various optical scenarios.
5. Illustrate the outline of application of lasers in Fiber Optics

Text books

1. K.R. Nambiar, *Lasers Principles, Types and Applications,* New Age International Publishers Ltd, New Delhi. (2014).
2. B.B. Laud, *Lasers and Nonlinear Optics,* 3rdEdn. New Age, New Delhi. (2011).
3. R.W. Boyd, *Nonlinear Optics*, 2ndEdn. Academic Press, New York, (2003).
4. G.P. Agarwal, *Fiber-Optics Communication Systems*, 3rdEdn. John Wiley,
5. Singapore. (2003).

Supplementary reading

1. W.T. Silvast, *Laser Fundamentals* Cambridge University Press, Cambridge (2003).
2. D.L. Mills, *Nonlinear Optics* – Basic Concepts (Springer, Berlin (1998).

OUTCOME MAPPING

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

SEMESTER : II **PART : Core Course**	**COURSE CODE : 22PPHYC21** **TITLE : QUANTUM MECHANICS**	**CREDITS : 4** **Hours/Week : 5**

COURSE OBJECTIVES

1. To introduce the basic postulates of quantum mechanics.
2. To make the student to understand exactly solvable systems.
3. To elucidate the aspects of time – independent and time-dependent perturbation theories.
4. To introduce the concepts of angular momentum and identical particles.
5. To make the students to understand relativistic quantum mechanics.

UNIT 1 : Foundations of wave mechanics

Schrodinger Equation – Physical meaning and conditions on the wave function – Expectationvalues and Ehrenfest's theorem – Hermitian operators and their properties – Commutator relations – Uncertainity relation – Bra and Ket Vectors – Hilbert space – Eigen value problem- Schrodinger , Heisenberg and interaction pictures.

UNIT 2 : Exactly solvable systems

Solving the one and three dimensional Schrodinger equation - Linear harmonic oscillator – Particle in a box – Square well potential – Rectangular barrier potential – Rigid rotator – Hydrogen atom.

UNIT 3 : Approximation methods

Time independent perturbation theory**:** Non-degenerate and degenerate case – Stark effect – WKB Approximation – Application to tunneling problem and potential well.Time dependent perturbation theory **–** Constant in time-Harmonic perturbation – Transition probability – Adiabatic and sudden approximation.

UNIT 4 : Angular momentum and identical particles

Angular momentum - Total Angular momentum operators - Spin angular momentum Commutation relation - Matrix representation of J – Eigen values of J_+ and J_- , J^2 and J_z ,and J_x and J_y - Matrix representation of J - Addition of angular momenta – Clesbch-Gordan coefficients – Pauli matrices –Identical particles and spin – Symmetric and Anti symmetric wave functions-Hydrogen molecule.

UNIT 5 : Relativistic quantum mechanics

Klein-Gordan equation for a free particle and in an electromagnetic field-Dirac's Relativistic equation – Dirac equation for a free particle –Dirac equation – Dirac matrices – Plane wave solution – Charge and current densities-Existence of electron spin - Negative energy states – Spin-orbit coupling – Zitterbewegung: jittery motion of a free particle.

COURSE OUTCOME

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

1. Recognize the concept of quantum mechanical tool
2. Describe the application of Schrodinger's equation to exactly solvable problems
3. Analyse the approximations of quantum mechanical problems.
4. Represent various momentum tools
5. Understand and apply the Relativistic quantum field.

Text books

1. SatyaPrakash and SwadiSaluja - *Quantum Mechanics*, Kadharnath, Ramnath publications. (2005)
2. SatyaPrakash – *Advanced Quantum Mechanics*, Arihant publications. (2012)
3. Gupta, Kumar, Sharma - *Quantum Mechanics*, Jai Prakashnath publications, Meerut. (2018)
4. V.Devanathan - *Quantum Mechanics*, Alpha Science Publications, 2nd Ed., (2020)

Supplement readings

1. L.Schiff - *Quantum Mechanics* Tata Mcgraw Hill, New Delhi. (1968)
2. G.Aruldhas - *Quantum Mechanics* PHI Ltd., (2008)
3. P.M.Mathews and K.Venkatesan - *A Text Book of Quantum Mechanics* -Tata
4. McGraw Hill, New Delhi. (1987)
5. V.K.Thankappan - *Quantum Mechanics* - Wiley –Eastern, New Delhi. (1985)
6. A.Goswami - *Quantum Mechanics* - W.C.Brown , Dubuque.(1992)

OUTCOME MAPPING

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

SEMESTER : II PART : Core Course	COURSE CODE : 22PHYC22 TITLE : MATHEMATICAL PHYSICS – II	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1. To make the students the understand partial differential equations in physics problems.
2. To make the student in gaining knowledge of complex variable.
3. To involve the student to learn special functions.
4. To educate the students to develop the understanding of integral transforms.
5. To introduce the probability theory.

UNIT 1 : Partial differential equations in physics problems

Solution of Second order Differential equation - with Constant Coefficients - with Variable Coefficients - Frobenius method – Problems - Solution of Laplace differential equations – Two Dimensional Steady flow of heat in Cartesian, Cylindrical Coordinates - Solution of variable heat flow in one dimension - Solution of variable heat flow in two dimension - Solution of wave equation - Solution of Schordinger equation for one dimensional Harmonic Oscillator.

UNIT 2 : Complex variable

Introduction – Function of a Complex variable - Analytic Function-Cauchy – Riemann conditions - proof - Sufficient conditions – proof - Polar form of Cauchy – Riemann Conditions –Harmonic function - Complex integrations – Contour - Cauchy's Integral Formula - Taylor's Expansion - Laurent' Series - Cauchy's residue theorem-problems.

UNIT 3 : Special functions

Legendre, Bessel, Hermite and Laguerre differential equations – Power series solutions –

Polynomials–Generating functions – Rodrigue's formula - Recursion relations – Orthogonality relations.

UNIT IV: Integral transforms

Introduction – Laplace Transform-Properties-Derivative of Laplace Transform-proof-Integration of Laplace transforms-Laplace Transform of Periodic Functions- Initial and final value theorems-Inverse Laplace Transform-properties-Fourier Transform-Fourier Cosine Transforms- Fourier sine Transforms-Linearity ,Similarity, Parseval's Theorem .Problems.

UNIT 5 : Probability theory

Theorem of Total Probability-Dependent and independent event-Distribution Functions-Constant of Bionomial, Normal, Poisson distribution - variance, Covariance and correlation-Arithmetic Mean and Estimate of Variance-theorem, proof-Theory of Errors - Problems.

COURSE OUTCOME

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

1. Apply Partial Differential equation to solve various physics problems.
2. Solve problems using complex variable method.
3. Evaluate problems using Special functions
4. Solve problems using Fourier series and Fourier transforms.
5. Analyse problems using Probability theory.

Text book

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

Supplement readings

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

OUTCOME MAPPING

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

SEMESTER : II	COURSE CODE : 22PPHYC23	CREDITS : 4
PART : Core Course	TITLE : THERMODYNAMICS AND STATISTICAL MECHANICS	Hours/Week : 5

COURSE OBJECTIVES

1. To provide adequate introduction on the postulates of Thermodynamics
2. To understand the Transport properties and related equilibrium concepts
3. To learn the basics of classical statistical mechanics and to understand some of their applications
4. To learn the basics of quantum statistical mechanics and to understand some of their applications
5. To train to apply quantum mechanical statistics to various applications

UNIT 1 : Thermodynamics and basic concepts

Basic postulates of Thermodynamical laws and consequences – Gibbs free energy and Helmholtz free energy – Thermodynamical potential – Entropy - Changes in entropy in reversible processes - Principle of increase of entropy - Phase transitions – Clausius - Clayperon equation – Gibb"s phase rule- van der Wall equation of state.

UNIT 2 : Kinetic theory and transport properties

Boltzmann transport equation and its validity – Boltzmann H theorem – Mean free path – Conservation laws – Transport phenomena – Equipartition and Virial theorems – Random walk - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Viscosity of gases – Thermal conductivity – Diffusion process - The heat equation

UNIT 3 : Classical statistics

Phase space - Density of states – Macro and micro states – Ensembles and their types – Statistical equilibrium - Liouville's theorem - Maxwell-Boltzmann's distribution law – Partition function- Principle of equipartition of energy – Entropy and Probability.

UNIT 4 : Bose – einstein statistics fermi-dirac statistics

Quantum statistics of identical particles — Bose–Einstein distribution law – Ideal Bose-Einstein gas – Degeneracy - Chemical potential of bosons – The principle of detailed balance – Bose-Einstein condensation

Fermi-Dirac distribution – Ideal Fermi - Dirac gas – Degeneracy – Weak degeneracy – Strong degeneracy.

UNIT 5 : Applications of quantum statistical mechanics

Phase transition – Phase transition of first and second kind- Phase diagrams for pure systems – Clausius - Clapeyron equation – Gibbs phase rule.

Ideal Bose system : Black body radiation – Planck's radiation law – Specific heat of solids – Einstein's theory – Debye's theory – Liquid Helium.

Ideal Fermi system : Electron gas in metals – Thermionic emission of electrons – Specific heat of gases – Variation with temperature- Pauli paramagnetism - Ising and Heisenberg models in Ferromagnetism

COURSE OUTCOME

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

1. Have adequate knowledge on the basics of thermodynamics.
2. Understand the kinetic theory and transport properties.
3. Know the Basic concepts of classical statistics and applications
4. Know the Basic concepts of quantum statistics.
5. Describe the role of quantum statistics to various real life problems.

Text books

1) S.K. Sinha, *Introduction to Statistical Mechanics*Narosa, New Delhi. (2007).
2) F. Reif, Fundamentals of Statistical and Thermal Physics McGraw Hill, Singapore. (1985).
3) Gupta M.C, *Statistical Thermodynamics* New Age International (P) Ltd., (1995).
4) Singhal, Agarwal, Prakash, *Thermodynamics and Statistical Physics*Prakashan, Meerut. (2003).

Supplementary readings

1) K. Huang, *Statistical Mechanics* Wiley Eastern Limited, New Delhi. (1963).
2) W. Greiner, L. Neise and H. Stocker, *Thermodynamics and Statistical Mechanics* Springer, New York. (1995).

OUTCOME MAPPING

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

SEMESTER: II PART:Core Practical	COURSE CODE: 22PPHYP24 TITLE : PRACTICAL – II : GENERAL & ELECTRONICS-II	CREDITS : 4 Hours/Week : 8

COURSE OBJECTIVES

1. To provide adequate introduction on the postulates of Thermodynamics
2. To understand the Transport properties and related equilibrium concepts
3. To learn the basics of classical and quantum statistical mechanics and to understand some of their applications
4. To study the microscopic and macroscopic properties of matter through the statistical probability laws and distribution of particles

List of Experiments (Any 15 out of the given 21)

GENERAL EXPERIMENTS - II (Choose Minimum 5 experiments)

1. Determination of Stefan's constant.
2. Thermistor-Band gap energy.
3. Specific charge of an electron -Thomson's method.
4. Lasers : Determination of particle size and Wave length.
5. Spectrometer - Charge of an electron.
6. Determination of dielectric constant of solid samples.
7. Identification of Prominent lines by spectrum photography – Brass spectrum.
8. Young's Modulus by Koenig's method.
9. Determination of Planck's constant.

ELECTRONICS EXPERIMENTS- II (Choose Minimum 7 experiments)

1. Study of (i) Multiplexer using IC 74150 for the generation of Boolean functions and (ii) Demultiplexer using IC 74154
2. Study the function of Decoder and Encoder.
3. IC 7490 -as modulus counters and display using IC-7447
4. Up-down counters - Design of modulus counters.
5. IC 7476 - 4 bit Shift Register - Ring counter and Johnson counters.
6. IC 555 – Astablemultivibrator and Voltage Controlled Oscillator.
7. IC 555 –Monostablemultivibrator and Frequency Divider.
8. IC 555 - Schmitt Trigger and Hysteresis.
9. A/D converter using comparator LM 339.
10. Study of A/D converters-4 bit simultaneous A/D converter and successive approximation A/D converter using ADC IC 0801/IC 0804.
11. Arithmetic operations (Adder/ Subtractor) Using IC 7483.
12. Design Full adder and Full subtractor using NAND/NOR gates.

COURSE OUTCOMES

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

1. Understand the basic laws and theories regarding the various properties of the materials.
2. Handle advanced instruments for the accurate determination of physical parameters.
3. Apply the theory to design the basic electronic circuits
4. Use of these basic circuits to create multivibrators, converters and flip flops etc.
5. To provide a hands-on learning experience and understand the basic concepts and applications of digital electronics.

Text books

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

Supplementary reading

1. Samir Kumar Ghosh, *A Textbook of Advanced Practical Physics*, NCBA, Kolkatta, (2000).
2. D. Chattopadyay, P.C.Rakshit, *An Advanced Course in Practical Physics*,NCBA, Kolkatta. (2011).

OUTCOME MAPPING

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

SEMESTER: II PART: Core Elective	COURSE CODE: 22PPHYE25-1 TITLE : NANO SCIENCE AND NANO TECHNOLOGY	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1. To provide the Knowledge about the basics of Nanoscience and Technology.
2. To understand the structures, properties, characterization and applications of nanomaterials.
3. To attain the knowledge about types of synthesis methods and characterization techniques.
4. To apply their acquired skill in research to synthesis and to select appropriate characterization for nanomaterials.
5. To acquire a knowledge about the types of nanomaterials used for various applications.

UNIT 1 : Introduction to nanotechnology and nanomaterials

Introduction - History - Definition and Nanoscale range - Evolution of nanotechnology in 20^{th} century - Concepts of 0D, 1D, 2D and 3D nanostructured materials - Quantum dots - Quantum wire - Quantum well. Types of nanomaterials: Carbon based materials - C_{60}: Buckminster fullerene - Carbon nanotubes: Structure - Types and Applications - Nano diamond. Metal based nanomaterials, Nanocomposites, Nano porous materials and Dendrimers.

UNIT 2 : Properties of nanomaterials

Physical properties of nanomaterials: Melting points - Specific heat capacity and lattice constants - Mechanical properties - Optical properties: Surface Plasmon Resonance - Quantum size effects - Electrical property: Surface scattering - Charge of Electronic structure - Quantum transport - effect of Microstructure. Variation of magnetism with size – Super para magnetism – Diluted magnetic semiconductors.

UNIT 3 : Synthesis methods

Methods to Synthesis Nanomaterials - Top down and bottom up approaches - Physical vapour deposition - Chemical vapour deposition - plasma arching - Ball milling technique - Reverse miceller technique - Nano lithography - Synthesis of oxide nanoparticles by sol-gel method – Hydrothermal Method - Electrochemical deposition method - Electrospinning method - Organic and inorganic hybrids, Self-assembly (Supramolecular approach).

UNIT 4 :Characterization of nanomaterials

Principle, Construction, working and Applications of Powder X-Ray Diffraction (XRD) - Fourier Transform Infrared Spectroscopy (FTIR) - Scanning Electron Microscopy (SEM) - Transmission Electron Microscopy (TEM) - Ultraviolet-Visible Spectroscopy (UV-VIS) - Vibrating Sample Magnetometer (VSM) - I-V Characteristics by Four Probe - and Photoluminescence (PL).

UNIT 5 : Applications

Molecular electronics and Nano electronics - CNT emitters - Photo electrochemical cells - Nano diodes, Nano switches - nanoparticles based solar cells - fuel cells, chemical sensors, catalysts, Colorants and pigments. Nanotechnology in Agriculture, Nanotechnology in Food, Nanotechnology in Textile industry and Nanotechnology in Environmental Conservation.

COURSE OUTCOMES

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

1. Differentiate the Different dimensions of nanomaterials
2. Apply their acquired knowledge to synthesis and to characterize the nanomaterials
3. Select the appropriate element and to synthesize the nanomaterials with desired property.
4. Identify the suitable characterization methods to characterize the prepared nanomaterials.
5. Realize the application of nanomaterials in various fields

Text books

1. T.Pradeep et al., *A Textbook of Nanoscience and Nanotechnology,* Tata McGraw Hill, New Delhi. (2012).
2. M.A.Shah, Tokeer Ahmad, *Principles of Nanoscience and Nanotechnology*, **Alpha Science International Ltd, (2010).**
3. G. Cao, *Nanostructures and Nanomaterials,* Imperial College Press, London. (2004).
4. Viswanathan B, *Nano Materials*, Narosa Publishing house.(2010).

Supplementary readings

1. C.P. Poole and F.J. Owens, *Introduction to Nanotechnology*,Wiley, New Delhi. (2003).
2. Pradeep T, *The Essentials, Nano*: Tata MC Graw-Hill publishing company limited. (2007).
3. Gregory Timp editor, *Nanotechnology*, AIP Press, Springer-Verlag, New York. (1999).
4. *William A. Goddard III, Donald Brenner, Sergey Edward Lyshevski, Gerald J Iafrate, Hand Book of Nanosciene, Engineering and Technology* – The Electrical Engineering handbook series, CRC Press, (2012).

OUTCOME MAPPING

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

SEMESTER : II PART : Core Elective	COURSE CODE : 22PPHYE25 - 2 TITLE : PETRO PHYSICS	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1. To learn the basics of magnetic properties of minerals
2. To understand knowledge on various fundamentals of geomagnetic elements.
3. To gain in depth knowledge about the classification of rock forming minerals and geophysicsal methods.
4. To study the importance of seismic waves
5. To study the geochronology and thermoluminescence.

UNIT 1 : Earth as a magnet

Magnetic properties of mineral systems – Intrinsic properties, magnetization process, weak field remanance.Remanance properties- NRM, TRM, CRM, DRM, VRM, PRM – their mechanisms –Thermal demagnetization technique – partial TRM – additive law – Neel's theory of TRM. Primary and Secondary magnetization – Testing for stability of remanance.

UNIT 2 :Geomagnetic elements

Geomagnetic elements of the earth – initial susceptibility of rocks – single and multidomain cases – Curie point determination and its importance. Laboratory and field instruments for magnetic measurements – Astatic magnetometer – spinner magnetometer – Fluxgate magnetometer – Theory, practice and applications.

UNIT 3 : Geo physical properties

Classification of rock forming minerals – physical properties of minerals with special reference to optical properties – elementary details of a polarizing microscope and petrographic analysis.Geophysical prospecting – different methods – Geophysical properties of rocks and minerals – Resistivity methods – Two current electrode method – measuring equipment – application to ground water survey.

UNIT 4 : Seismic waves

Seismic waves – S waves & P waves – elastic, plastic behavior of rocks – modulus of elasticity in rocks – Time distance curves and the location of epicenters – recent developments.

Seismic waves – S waves & P waves – elastic, plastic behavior of rocks – modulus of elasticity in rocks – Time distance curves and the location of epicenters – recent developments.

UNIT 5 :Geochronology

Geochronology – the geological time scale – archaeo-magnetic dating – Radioactive methods of dating – Rubidium, Strontium method – Potassium Argon method – Thermoluminescence.

COURSE OUTCOMES

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

1. Understand the various magnetites and behaviour of the remenance properties.
2. Study the geomagnetic elements of the earth and various magnetometer instruments.
3. Understand the classification and properties of of rock forming minerals
4. Highlight the concept of seismic waves and various dating methods.
5. Study the geochronology and thermoluminescence.

Text books

1. RL. Singhal, *Solid State Physics*KedarnathRamnath& Co. Meerut(2018).
2. A.J. Dekker, *Solid State Physics*, Prentice Hill. (2015).
3. Saxena and Gupta and Saxena, *Solid State Physics*, PragatiPrakash, Meerut. (2016).
4. Eve and Keys, *Applied Geophysics*, Cambridge University Press. (1933).
5. W.O. Reilly, *Rock and Mineral magnetism, Blackmoore*. (1984).

Supplementary reading

1. Howell, *Introduction to Geophysics,* McGraw Hill Book Co. (2013).
2. G.D. Garland, *Introduction to Geophysics*, Saunder's Book Co., 2nd Edn. (1979).
3. McElhinny, *Paleomagnetism and Plate Tectonics,* Cambridge University Press. (1973).
4. Dobrin, *Introduction to Geophysical prospecting,* McGraw Hill Book Co. (1988).

OUTCOME MAPPING

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

SEMESTER : II PART:Core Elective	COURSE CODE: 22PPHYE25 – 3 TITLE : COMMUNICATION ELECTRONICS	CREDITS : 4 Hours/Week : 5

COURSE OBJECTIVES

1. To understand the basics of wave propagations and the concepts of micro wave communication
2. To learn the basic principles of Fiber Optics Communication & networking system.
3. To study the elements of RADAR communication.
4. To update the knowledge on satellite communication and the equipment used.
5. To introduce the preliminary concepts of mobile communication systems.

UNIT 1 : Wave propagation and micro wave communication:

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

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

UNIT 2 : Optical fibre communication:

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

UNIT 3 : Radar communication:

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

UNIT 4 : Satellite communication:

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

UNIT 5: Mobile communication:

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

COURSE OUTCOMES

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

1. Know the basics of wave propagations and the concepts of micro wave communication
2. Understand the basic principles of Fiber Optics Communication & Networking system.
3. Describe the elements of RADAR communication.
4. Acquire the knowledge on satellite communication and the equipments used.
5. Learn and apply the preliminary concepts of mobile communication systems.

Text books

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

Supplementary readings

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

OUTCOME MAPPING

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