Lesson Plan - B.Sc. Physics

PH1 B01: METHODOLOGY OF SCIENCE AND PHYSICS

Semester: 1
Course Number: I
Number of hours of Lectures per week: 2
Number of Credits: 2
Number of Contact Hours: 36
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To get a general idea about what is science, what is scientific temper,history of science and scientific revolutions
- To Familiarize with the different steps involved in the scientific method with the help of a flow chart, explaining what is hypothesis and how they become scientific laws
- To get awareness of a brief history of physics, giving emphasis on the birth of quantum theory using black body radiation, photoelectric , X rays and DeBroglie waves and a general idea about theory of relativity
- To understand mathematical methods physicists often use, including differential Calculus,The operator ∇- Gradient, Divergence, Curl, integral calculus, matrices and curvilinear coordinates

Prerequisites: Background of the basic science at +2 level

COURSE OUTLINE

Part A: Methodology And Perspectives Of Sciences
Unit I – Science and Science Studies - Types of knowledge: Practical, Theoretical, and Scientific knowledge, Information. What is Science; what is not science; laws of science. Basis for scientific laws and factual truths. Science as a human activity, scientific temper, empiricism, vocabulary of science, science disciplines. Revolution in science and Technology.

Unit II – Methods and tools of science- Hypothesis: Theories and laws in science. Observations, Evidences and proofs. Posing a question; Formulation of hypothesis; Hypothetico-deductive model, Inductive model. Significance of verification (Proving), Corroboration and falsification (disproving), Auxiliary hypothesis, Ad-hoc hypothesis.
Revision of scientific theories and laws, Importance of models, Simulations and virtual testing, Mathematical methods vs. scientific methods. Significance of Peer Review.

Reference Books:

1. Gieryn, T F. Cultural Boundaries of Science., Univ. of Chicago Press, 1999
2. Collins H. and T Pinch., The Golem: What Everyone Should Know About Science., Cambridge Uni. Press, 1993
3. Hewitt, Paul G, Suzanne Lyons, John A. Suchocki & Jennifer Yeh, Conceptual Integrated Science. Addison-Wesley, 2007
4. Newton R G. The Truth of Science: New Delhi, 2nd edition
5. Bass, Joel E and et. al. Methods for Teaching Science as Inquiry, Allyn & Bacon, 2009

Part B: Methodology and Perspectives of Physics

What does Physics deal with? - brief history of Physics during the last century-the inconsistency between experiments and theories- Birth of new science concepts - Quantum concepts-Black body radiation, Photoelectric effect, X-rays, De Broglie waves,Relativity-Special relativity, Time dilation, Length contraction, Twin paradox Laser- Concepts of ordinary and monochromatic light, Coherent and incoherent light, Spontaneous and stimulated emission, Metastable state, pumping and population inversion Design of an experiment , experimentation , Observation, data collection: Interaction between Physics and technology.

References:

1. Concepts of Modern Physics- Arthur Beisser
2. A brief history and Philosophy of Physics - Alan J. Slavin- http:/ www.trentu. Ca/ academic / history- 895 .html
3. The inspiring History of Physics in the Last One Hundred Years : Retrospect and prospect Prof. Dr-Ing . Lu Yongxiang http :// www.twas .org.cn/twas/proLu.asp

Part C – Mathematical Methods in Physics

Vector Analysis: – Vector Operations - Vector Algebra – Component form – How vectors transform, Applications of vectors in Physics. Differential Calculus: – The operator - Gradient, Divergence, Curl – Physical interpretation - Product rules of - Second derivatives. Integral Calculus: – Line integral, surface integral and volume integral - Fundamental theorem of Gradients – Gauss’s Divergence Theorem (Statement only)– The fundamental theorem of curl – Stoke’s theorem(Statement only). Divergence less and curlless fields. Curvilinear co-ordinates: – Spherical polar coordinates – cylindrical coordinates(Basic ideas).

Matrices: – Basic ideas of matrices – addition, subtraction, scalar multiplication, Transpose of a matrix, conjugate of a matrix, diagonal matrix - Representation of vectors as column matrix – Determinants – Cramer’s rule – EigenValues and EigenVectors - Hermitian Matrix,Unitary Matrix.

References:

1. Introduction to Electrodynamics – David J . Griffiths, Prentice Hall India Pvt. Ltd., Chapter – 1
2. Mathematical Physics - Satya Prakash, Sultan Chand &Sons, New Delhi
3. Mathematical Physics – BD Guptha
4. Mechanics-J.C .Upadhyaya

COURSE OUTCOMES

CO1	Understand and apply the methodology and perspectives of science
CO2	Understand and apply the methodology and perspectives of science
CO3	Understand and apply the mathematical method in Physics

LESSON PLAN

Unit/ session/ hours (timerequire d)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (10 Hours)	What is Science; what is not science; laws of science. Basis for scientific laws and factual truths. Science as a human activity, scientific temper Formulation of hypothesis; Hypothetico-deductive model, Inductive model. Significance of verification (Proving), Corroboration and falsification (disproving), Auxiliary hypothesis, Ad-hoc hypothesis	Lecture Numerical problem solving	Discussion Assignment	Understanding basic methodology of science	Class participation , test papers
UNIT II (9 Hours)	brief history of Physics during the last century- Birth	Lecture Numerical problem	Assignment seminar\presentation	Understanding the methodolo	Class participation Quiz

	of new science concepts - Quantum concepts-Black body radiation, Photoelectric effect, Laser- Concepts of ordinary and monochromatic light, Coherent and incoherent light, Spontaneous and stimulated emission,	solving discussion		gy of physics	Test papers
UNIT III (17 Hours)	Vector Analysis:Differential Calculus, Integral Calculus, Curvilinear co-ordinates, Matrices	Lecture and discussion Numerical problem solving	Assignment Seminar	Understading the mathematical methods in physics	Test papersAssignment class participation

Faculty In-charge
Dr.Nijo Varghese & Dr. Salini Jose

PH2 B02: PROPERTIES OF MATTER, WAVES & ACOUSTICS

Semester: 2
Course Number: II
Number of hours of Lectures per week: 2
Number of Credits: 2
Number of Contact Hours: 36
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To Learn the basics of properties of matter, how Young's modulus and rigidity modulus are defines and how they are evaluated for different shapes of practical relevance
- To Learn the fundamentals of harmonic oscillator model, including damped and forced oscillators and grasp the significance of terms like quality factor and damping coefficient
- To Study the general equation of wave motion in general and TM waves in stretched strings and longitudinal waves in gases

- To get Familiarise with general terms in acoustics like intensity, loudness, reverberation etc, and study in detail about production, detection, properties and uses of ultrasonic waves.

Prerequisites: Background of the basic science at +2 level

COURSE OUTLINE

Unit-1: Properties of Matter

Elasticity: Basic ideas, Work Done per Unit Volume, Relations between elastic constants, Poisson's Ratio, Limiting Values of Poisson's Ratio, Twisting Couple on a Cylinder (or a Wire), Torsion pendulum, Determination of Rigidity Modulus, Bending of Beams, Bending Moment, Cantilever Loaded at Free End, Depression of a Beam Supported at the Ends and Loaded at the Centre (weight of the beam neglected), Determination of Y by Bending of a Beam, I form of Girders.

Unit-2 Harmonic Oscillator

Periodic Motion, Simple Harmonic Motion and Harmonic Oscillator, Energy of a Harmonic Oscillator, Examples of Harmonic Oscillator, Anharmonic Oscillator, Composition of Two Simple Harmonic Motions of Equal Periods in a Straight Line, Composition of Two Rectangular Simple Harmonic Motions of Equal Periods: Lissajous Figures, Damping Force, Damped Harmonic Oscillator, Examples of Damped Harmonic Oscillator, Power Dissipation, Quality Factor, Forced Harmonic Oscillator

Unit-3 Waves

Wave Motion, General Equation of Wave Motion, Plane Progressive Harmonic Wave, Energy Density for a Plane Progressive Wave, Intensity of a Wave, Transverse Waves in Stretched Strings, Modes of Transverse Vibrations of Strings, Longitudinal Waves in Rods and Gases, Fourier's Theorem, Wave Velocity and Group Velocity

Unit-4 Acoustics

Intensity of Sound- Decibel and Bel, Loudness of Sound, Noise Pollution, Ultrasonics: Production of Ultrasonic Waves- Piezo Electric Crystal Method, Determination of Velocity of Ultrasonic Waves in a Liquid - Acoustic Grating , Application of Ultrasonic Waves, Reverberation, Sabine's Formula (Derivation not required), Absorption Coefficient, Acoustics of Buildings

Text books for Study

1. Elements of Properties of Matter by D.S. Mathur 2008

2. Mechanics by J.C Upadhyaya 2003
3. Properties of Matter and Acoustics by R.Murugeshan & Kiruthiga Sivaprasath 2005

Reference

1. Mechanics -- D.S. Mathur
2. Text book of Sound –Brij Lal& Subramaniam
3. Text book of Sound –Khanna .D.R. & Bedi.R.S.
4. Berkeley Physics course Vol 3 on Waves
5. Elements of Mechanics – K Rama Reddy, S Raghavan & D V N Sarma- Universities Press
6. Introduction to Mechanics – Mahendra K Verma – Universities Press

COURSE OUTCOMES

CO1	Understand the properties of matter
CO2	Understand and apply the Harmonic oscillator
CO3	Understand the concept of waves
CO4	Understand and apply the concept of acoustics

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (9 Hours)	Elasticity:Poisson's Ratio,Torsion pendulum, Bending of Beams, Bending Moment, Cantilever Loaded at Free End, Depression of a Beam Supported at the Ends and Loaded at the Centre	Lecture Numerical problem solving	Discussion Assignment	Understanding basic properties of matter	Class participation , test papers
UNIT II	Periodic Motion,	Lecture	Assignment	Understan	Class

(14 Hours)	Simple Harmonic Motion and Harmonic Oscillator, Energy of a Harmonic Oscillator, Examples of Harmonic Oscillator, Anharmonic Oscillator, Composition of Two Simple Harmonic Motions of Equal Periods in a Straight Line,	Numerical problem solving discussion	seminar\presentation	ding the harmonic oscillator	participation Quiz Test papers
UNIT III (8 Hours)	Wave Motion, General Equation of Wave Motion, Plane Progressive Harmonic Wave, Energy Density for a Plane Progressive Wave, Intensity of a Wave, Transverse Waves in Stretched Strings,	Lecture and discussion Numerical problem solving	Assignment Seminar	Understanding the concept of waves	Test papers Assignment class participation
UNIT IV (5 Hours)	Intensity of Sound-Decibel and Bel, Loudness of Sound, Noise Pollution, Ultrasonics: Production of Ultrasonic Waves-Piezo Electric Crystal Method,	Lecture and discussion Numerical problem solving	Assignment Seminar	Understanding the concept of Acoustics	Test papers Assignment class participation

Faculty In-charge
Dr.Nijo Varghese & Dr. Salini Jose

PH3 B03: MECHANICS

Semester: 3
Course Number: III
Number of hours of Lectures per week: 3
Number of Credits: 4
Number of Contact Hours: 54
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To Understand the motion of objects in different frame of references
- To Understand laws of motion, reference frames, and its applications i.e. projectile motion, simple harmonic oscillator, Rocket motion, elastic and inelastic collisions.
- To Understand the idea of conservation of angular momentum, central forces and the effective potential
- To Develop understanding of special theory of relativity and its applications

Prerequisites: Background of the basic science at +2 level

COURSE OUTLINE

UNIT-1

1. Frames of reference - Laws of Mechanics, Inertial frames of reference, Galilean transformation equations, Hypothesis of Galilean invariance, Conservation of Momentum, Non inertial frames and fictitious forces, Rotating frames of reference, Centrifugal force and Coriolis force, Foucault's pendulum

2. Conservation of Energy
Conservation laws, Conservative forces, Conservation of energy for a particle: Energy function, Potential energy curve, Non conservative forces

3. Linear and Angular Momentum
Conservation of linear momentum, Centre of mass, ,Centre of mass frame of reference, Collision of two particles ,Deflection of a moving particle by a particle at rest, Rockets, Angular momentum and torque, Motion under central force, Areal velocity, Conservation of angular momentum with examples

4. Potentials and Fields
Central force, Inverse square law force, Potential energy of a system of masses, Gravitational field and potential, Escape velocity, Keplar's laws, Newton's deductions from Keplar's laws

UNIT-2

5 Lagrangian formulations of Classical Mechanics

Constraints, Generalized co-ordinates, Principle of virtual work, D'Alembert's principle, Lagrange's equations, Kinetic energy in generalized co-ordinates, Generalized momentum, Cyclic co-ordinates, Conservation laws and symmetry properties-Hamiltonian of a system

UNIT-3

6. Special Theory of Relativity

Electromagnetism and Galilean transformation, Michelson Morley experiment, Ether hypothesis, Postulates of Special Theory of Relativity, Lorentz transformation equations, Velocity transformation, Length contraction, Time dilation, Simultaneity, Mass in relativity, Mass and energy ,Space time diagram, Geometrical interpretation of Lorentz transformation, Principle of covariance, Four-vectors in Mechanics

Text books for study

1. Mechanics by J C Upadhyaya 2003 edition
2. Classical Mechanics by Takwale and Puranik
3. Classical Mechanics by Hans and Puri
4. Classical Mechanics by J C Upadhyaya

References

1. Mechanics by D.S.Mathur
2. Classical Mechanics by Goldstein
3. Berkeley Physics course Vol 1
4. Feynman Lectures on Physics Vol 1
5. Elements of Mechanics – K Rama Reddy, S Raghavan & D V N Sarma- Universities Press
6. Introduction to Mechanics – Mahendra K Verma – Universities Press
7. Classical Mechanics-Aruldhas

COURSE OUTCOMES

CO1	Understand and apply the basic concepts of Newtonian Mechanics to Physical Systems
CO2	Understand and apply the basic idea of Classical Mechanics

CO3	Understand and apply the special theory of relativity

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (32 Hours)	1. Frames of reference 2. Conservation of Energy 3. Linear and Angular Momentum 4. Potentials and Fields	Lecture Numerical problem solving	Discussion Assignment	Understanding basic laws of nature , observing the systems of physics	Class participation , test papers
UNIT II (9 Hours)	Central force, Inverse square law force, Potential energy of a system of masses, Gravitational field and potential	Lecture Numerical problem solving discussion	Assignment seminar\presentation	Understanding the concepts of classical Mechanics	Class participation Quiz Test papers
UNIT III (13 Hours)	Electromagnetism and Galilean transformation, Michelson Morley experiment, Ether hypothesis, Postulates of Special Theory of Relativity, Lorentz transformation equations, Velocity transformation, Length contraction, Time dilation,	Lecture and discussion Numerical problem solving	Assignment Seminar	Understanding the concept of special theory of relativity	Test papers Assignment class participation

Faculty In-charge
Dr.Nijo Varghese & Fency K F

PH4 B04: ELECTRODYNAMICS – I

Semester: 4
Course Number: IV
Number of hours of Lectures per week: 3
Number of Credits: 4
Number of Contact Hours: 54
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To Understand and analyze the electrostatic properties of physical systems
- To Understand the special techniques for calculating potentials
- To Understand the mechanism of electric field in matter.
- To Understand the mechanism of magnetic field in matter.

Prerequisites: Background of the basic science at +2 level

Unit 1 – Electrostatics

Electrostatic field – Coulomb's law, Electric field, Continuous charge distributions - Divergence and curl of electrostatic field, Field lines and Gauss's law, The divergence of E, Applications of Gauss law, Curl of E – Electric potential – Comments on potential, Poisson's equation and Laplace's equation, The potential of a localized charge distribution, Electrostatic boundary conditions – Work and energy in electrostatics, The work done in moving a charge, The energy of point charge distribution, The Energy of a continuous charge distribution, Comments on Electrostatic energy – Conductors, Basic properties of conductors, Induced charges, The Surface charge on a conductor, The force on surface charge, Capacitors.

UNIT 2 - Special Techniques for Calculating Potentials

Laplace's equation in One Dimension, Two Dimensions and Three Dimensions, Uniqueness theorems - Method of images, The classic image problem, induced surface charge, force and energy.

Unit 3 – Electric fields in matter

Polarization – Dielectrics, Induced dipoles, Alignment of polar molecules, Polarization – The field of a polarized object , Bound charges, Physical interpretation of bound charges, The field inside a dielectric – The electric displacement – Gauss's law in presence of dielectrics, Boundary conditions for D – Linear dielectrics, Susceptibility, Permittivity, Dielectric constant, Boundary value problems with linear dielectrics, Energy in dielectric systems, Forces on dielectrics.

Unit 4 – Magnetostatics

The Lorentz force law – Magnetic fields, Magnetic forces, cyclotron motion, cycloid motion, Currents, Linear, Surface and Volume current density – Biot -Savart law, The magnetic field of steady current – Divergence and curl of B, Straight line currents, Applications of Ampere's law, Magnetic field of a toroidal coil, Comparison of magnetostatics and electrostatics – Magnetic vector potential , Vector potential, Magnetostatic boundary conditions.

Unit 5 – Magnetostatic fields in matter

Magnetization – Diamagnets, Paramagnets and Ferromagnets, Torques and forces on magnetic dipoles, Effect of a magnetic field on atomic orbits, Magnetization – Field of a magnetised object, Bound Currents, Physical interpretation of bound currents, Magnetic field inside matter – Auxiliary field H, Ampere's law in magnetized materials, Boundary conditions – Linear and nonlinear media, Magnetic susceptibility and permeability, Ferromagnetism.

Textbook for study

Introduction to Electrodynamics by David J Griffiths, 3rd Ed.

References

1. Electricity and magnetism by Arthur F Kip
2. Physics Vol. II by Resnick and Halliday
3. Electricity and Magnetism- Berkley series
4. Electricity and Magnetism-Hugh D Young and Roger A Freedman

COURSE OUTCOMES

CO1	Understand and analyze the electrostatic properties of physical systems
CO2	Understand the special techniques for calculating potentials
CO3	Understand the mechanism of electric field

	matter.
CO4	Understand and analyze the magnetic properties of physical systems
CO5	Understand the mechanism of magnetic field in matter.

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (20 Hours)	Coulomb's law, Gauss's law, Applications of Gauss law, Electric potential, Work and energy in electrostatics, Conductors, Capacitors	Lecture Numerical problem solving	Discussion Assignment	Understanding basic concepts of Electrostatics	Class participation , test papers
UNIT II (6 Hours)	Laplace's equation in One Dimension, Two Dimensions and Three Dimensions, Uniqueness theorems - Method of images, The classic image problem,	Lecture Numerical problem solving discussion	Assignment seminar\presentation	Understanding the Special Techniques for Calculating Potentials	Class participation Quiz Test papers
UNIT III (8 Hours)	Polarization, The electric displacement, Gauss's law in presence of dielectrics, Linear dielectrics, Susceptibility, Permittivity, Energy	Lecture Numerical problem solving	Discussion Assignment	Understanding electric field in matter	Class participation , test papers

	in dielectric systems, Forces on dielectrics				
UNIT IV (12 Hours)	The Lorentz force law, Biot -Savart law, Applications of Ampere's law, Comparison of magnetostatics and electrostatics, Magnetostatic boundary conditions.	Lecture Numerical problem solving discussion	Assignment seminar\presentation	Understanding the concepts of Magnetostatics	Class participation Quiz Test papers
UNIT V (8 Hours)	Magnetization – Diamagnets, Paramagnets and Ferromagnets, Bound Currents, Boundary conditions – Linear and nonlinear media, Magnetic susceptibility and permeability, Ferromagnetism	Lecture Numerical problem solving	Discussion Assignment	Understanding basic concepts of magnetic field	Class participation , test papers

Faculty In-charge
Dr.Nijo Varghese & Fency K F

PH4B05 Practical-I (Credit 5)

Semester: 1,2,3 &4
Course Number: XIV
Number of hours of Lectures per week: 4
Number of Credits: 5
Number of Contact Hours:72
Course Evaluation: Internal – 30 Marks + External – 120 Marks

Objectives

- To Apply and illustrate the principles of semiconductor diode and transistor through experiments
- To Apply and illustrate the principles of transistor amplifier and oscillator through experiment
- To Apply and illustrate the principles of digital electronics through experiments
- To Analyze and apply computational techniques in Python programming

Prerequisites: Background of the basic practical knowledge at +2 level

Course Outline

1st, 2nd , 3rd & 4th SEMESTER EXPTS
(Any Ten from Each Part)
Part A
1. Young's modulus-non uniform bending-using pin and microscope-(load-extension graph).
2. Young's modulus-Uniform bending-using optic lever
3. Young's modulus-Angle between the tangents
4. Surface Tension-capillary rise method-radius by vernier microscope
5. Viscosity-Poiseuille's method –(Variable Pressure head, radius by mercury pellet method, sensibility method to find mass)
6. Moment of inertia-Flywheel
7. Moment of Inertia-Torsion Pendulum
8. Rigidity modulus-static torsion
9. Compound pendulum-acceleration due to gravity, Radius of gyration
10. Liquid lens-Refractive index of liquid and glass
11. Spectrometer-solid prism-Refractive index of glass measuring angle of minimum deviation.
12. Spectrometer-solid prism- Dispersive power

Part B
13. Deflection magnetometer-Tan A, Tan B positions
14. Deflection magnetometer -Tan C Position-moment of moments
15. Searle's vibration magnetometer-moment & ratio of moments
16. Box type vibration magnetometer-m & Bh
17. Melde's string arrangement-Frequency, relative density of liquid and solid (both modes)
18. Ballistic galvanometer-figure of merit
19. Potentiometer-measurement of resistance
20. Potentiometer-calibration of ammeter
21. Ballistic Galvanometer- BG constant using HMS-then find Bh.
22. B.G.-Comparison of capacities Desauty's method.
23. Spectrometer- i-d curve
24. Verification of Thevenin's theorem.

Books of Study:

1. Electronics lab manual- K A Navas (vol 1 &2)
2. B.Sc Practical Physics- C L Arora
3. Practical Physics- S L Gupta & V Kumar

Reference Books:

1. Advanced Practical Physics for students – B L Worksnop and H T Flint

COURSE OUTCOMES

CO1	Apply and illustrate the concepts of properties of matter through experiments
CO2	Apply and illustrate the concepts of electricity and magnetism through experiments
CO3	Apply and illustrate the concepts of optics through experiments
CO4	Apply and illustrate the principles of electronics through experiments

LESSON PLAN

Experiments to be done (input)	**Procedure (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
Part A 1. Young's modulus-non uniform bending-using pin and microscope-(load-extension graph). 2. Young's modulus-Uniform bending-using optic lever 3. Young's modulus-Angle between the tangents 4. Surface Tension-capillary rise	• Demonstrations •ComparativeStudy	• Assignment • Seminars	Getting practical knowledge about Physics Experiments	• Practical exams • Assignment

method-radius by vernier microscope 5. Viscosity-Poiseuille's method –(Variable Pressure head, radius by mercury pellet method, sensibility method to find mass) 6. Moment of inertia-Flywheel 7. Moment of Inertia-Torsion Pendulum 8. Rigidity modulus-static torsion 9. Compound pendulum-acceleration due to gravity, Radius of gyration 10. Liquid lens-Refractive index of liquid and glass 11. Spectrometer-solid prism-Refractive index of glass measuring angle of minimum deviation. 12. Spectrometer-solid prism- Dispersive power **Part B** 13. Deflection magnetometer-Tan A, Tan B positions 14. Deflection magnetometer -Tan C				

Position-moment of moments 15. Searle's vibration magnetometer-moment & ratio of moments 16. Box type vibration magnetometer-m & Bh 17. Melde's string arrangement-Frequency, relative density of liquid and solid (both modes) 18. Potentiometer-measurement of resistance 19. Potentiometer-calibration of ammeter 20. B.G.-Comparison of capacities Desauty's method. 21. Spectrometer- i-d curve 22. Verification of Thevenin's theorem.				

Faculty In-charge
Dr.Nijo Varghese & Fency K F

PH5 B06: ELECTRODYNAMICS-II

Semester: 5
Course Number: VI
Number of hours of Lectures per week: 3
Number of Credits: 3
Number of Contact Hours: 54
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To enable to solve a variety of problems related to Faraday's law of induction and Maxwell's equations.
- To understand the relevance of displacement current in the context of electromagnetic wave propagation.
- To study in depth the transient current response of CR, LC, CR and LCR circuits, which is essential in designing as well as understanding the working of electronic circuits.
- To solve complex problems involving linear electrical networks employing the symmetry concepts together with various network theorems .

Prerequisites: Background of the basic science at +2 level

COURSE OUTLINE

Unit 1 – Electrodynamics

Electromotive force – Ohm's law, electromotive force, motional emf – Electromagnetic induction - Faraday's law, induced electric field, inductance, energy in magnetic fields – Maxwell's equations – Electrodynamics before Maxwell, Maxwell's modification of Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations inside matter, Boundary conditions – Continuity equation – Poynting's theorem

Unit 2 – Electromagnetic waves

Waves in one dimension, The wave equation, sinusoidal waves, boundary conditions :reflection and transmission, Polarization – Electromagnetic waves in vacuum , Wave equation for E and B, monochromatic plane waves in vacuum, energy and momentum ofE.M. waves, Poynting vector - Electromagnetic waves in matter, Propagation through linear media, reflection and transmission at normal incidence.Potential formulation – Scalar and vector potentials, Gauge transformations, Coulomb gauge and Lorentz gauge.

Unit 3 – Transient currents

Types of transients – DC transient currents in R-L circuits – Short circuit current – Time constant – DC transient currents in R-C circuits – Double energy transients – Theory of BG

Unit 4 – AC circuits

A resonant circuit – Alternating current – Alternating current networks – Admittance and impedance – Power and energy in AC circuits

Unit 5 – Network theorems

Kirchhoff's laws, Voltage sign and current direction, Solution of simultaneous equations using determinants, Source conversion, Superposition theorem, Ideal equivalent circuits,Thevenin's theorem, Reciprocity theorem, Delta / Star transformation – Star / Delta transformation – Norton's theorem, Maximum power transfer theorem.

Textbooks for study

1. Introduction to Electrodynamics by David J Griffiths, 3rd ed.
2. Electricity and Magnetism by R.Murugeshan (Third revised edition)
3. Electrical technology by Theraja

References

1. Electricity and magnetism by Arthur F Kip
2. Physics Vol. II by Resnick and Halliday
3. Electricity and Magnetism by D.N Vasudeva (Twelfth revised edition)
4. Introductory AC Circuit theory – K Mann & G J Russell- Universities Press
5. Electrical Circuit analysis –K Sureshkumar,NIT

COURSE OUTCOMES

CO1	Understand the basic concepts of electrodynamics
CO2	Understand and analyze the properties of electromagnetic waves
CO3	Understand the behavior of transient currents
CO4	Understand the basic aspects of ac circuits
CO5	Understand and apply electrical network theorems

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (15 Hours)	Electromotive force – Ohm's law, Electromagnetic induction, Maxwell's equations, Boundary conditions – Continuity equation – Poynting's theorem	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To acquire knowledge about emf, Ohm's law, poynting theorem	• Class test • Questioning
UNIT II (15 Hours)	Waves in one dimension, The wave equation, Polarization, Wave equation for E and B, energy and momentum ofE.M. waves, Electromagnetic waves in matter, Potential formulation, Gauge transformations	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To learn about waves	• Class test • Questioning
UNIT III (8 Hours)	Types of transients, DC transient currents in R-L circuits, Time constant, DC transient currents in R-C circuits, Theory of BG	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To know more about transient currents	• Class test • Questioning
UNIT IV (8 Hours)	A resonant circuit, Alternating current, Alternating current networks, Admittance and	• Lecture • Demonstrations	• Assignment • Discussion • Simplific	• To acquire knowledge about AC, Power and energy	• Class test • Questioning

	Impedance, Power and energy in AC circuits		ations		
UNIT V (8 Hours)	Kirchhoff's laws, Thevenin's theorem, Reciprocity theorem, Delta / Star transformation, Star / Delta transformation, Norton's theorem, Maximum power transfer theorem	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To acquire knowledge about Kirchhoff's Laws, norton's , maximum power transfer theorem etc	• Class test • Questioning

Faculty In-charge
Dr.Nijo Varghese

PH5 B07: QUANTUM MECHANICS

Semester: 5
Course Number: VII
Number of hours of Lectures per week: 3
Number of Credits: 3
Number of Contact Hours: 54
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

- To become familiar with Blackbody radiation, Ultraviolet catastrophe,PhotoElectric effect and Compton Effect
- To gain a clear knowledge about wave properties of particles,De Broglie waves and its implications on the uncertainty principle.
- To Study the Bohr Atom model in detail and understand about atomic excitations
- To grasp the idea of Wave Mechanics and gain the concept of eigen values, eigen functions and learn the basic postulates of quantum mechanics
- To find solution to Schrödinger's equation for many systems such as particle in a box, Hydrogen Atom and familiarize with different quantum numbers.

Prerequisites: Background of the basic science at +2 level

COURSE OUTLINE

UNIT 1

1. Particle Properties of Waves
Electromagnetic waves, black body radiation, ultraviolet catastrophe, Photoelectric effect, nature of light, wave particle duality, Compton Effect & its demonstration. Pair production, photons & gravity.

2. Wave Properties Of Particles
De Broglie waves, waves of probability, phase velocity & group velocity, particle diffraction, Davisson And Germer experiment, Electron Microscope, Uncertainty principle I, Uncertainty principle II, Applying the uncertainty principle, Energy & time uncertainty.

3. Atomic Structure
The Bohr atom-energy levels and spectra, correspondence principle, nuclear motion, atomic excitation, Frank-Hertz experiment

UNIT 2

4. Wave Mechanics
Classical mechanics is an approximation of quantum mechanics, wave function, Schrodinger equation-time dependant form, linearity & super position, expectation values, operators, Schrodinger equation-steady state form, eigen values & eigen functions, postulates of quantum mechanics, particle in a box, finite potential well, tunnel effect scanning tunneling microscope, harmonic oscillator wave function, energy levels, zero point energy.

5. Hydrogen Atom
Schrodinger equation for the hydrogen atom, separation of variables, quantum numbers, principal quantum number, orbital quantum number, magnetic quantum number, electron probability density, radiative transitions, selection rules, Zeeman effect, electron spin, exclusion principle, Stern-Gerlach experiment.

Textbooks for study

Concepts of Modern Physics 6th Edition-By Arthur Beiser

References

1. Modern Physics(II Edn.)-Kenneth Krane
2. Quantum Physics Of Atom, Molecules, Solids, Nuclei & Particles By R.Eisberg & R. Resnick (John Wiley)
3. Quantum Mechanics By G. Aruldhas

4. Berkeley Physics Course: Quantum Physics By Wichmann
5. University Physics – Zemansky
6. Quantum Mechanics – Trilochan Pradhan – Universities Press
7. Advanced Physics Second Edition – Keith Gibbs – Cambridge University Press
8. Introduction to Vector spaces in Physics - K A I L Wijewardena Gamalath – Foundation Books
9. Quatum Mechanics –Iswarsingh Thyagi
10. Feynman Lectures

COURSE OUTCOMES

CO1	Understand the particle properties of electromagnetic radiation
CO2	Describe Rutherford – Bohr model of the atom
CO3	Understand the wavelike properties of particles
CO4	Understand and apply the Schrödinger equation to simple physical systems
CO5	Apply the principles of wave mechanics to the Hydrogen atom

LESSON PLAN

Unit/ session/ hours (timerequire d)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (24 Hours)	1. Particle like Properties of Electromagnetic Radiation - Review of electromagnetic waves , Photoelectric effect, Blackbody radiation, Compton effect, Other photon processes	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To understand particle like properties of em radiation • To understand wave like properties of	• Class test • Questioning

	2. Wavelike Properties of Particles- De Broglie hypothesis, Uncertainty relationships for classical waves, Heisenberg uncertainty relationships 3. Rutherford-Bohr Model of the Atom - Basic properties of atoms, Thomson model, Rutherford nuclear atom, Line spectra, Bohr Model, Frank-Hertz experiment, Correspondence principle			particles • To learn Atom model and its properties	
UNIT II (16 Hours)	4. The Schrodinger Equation -The Schrodinger recipe, Probabilities and Normalization, Applications, Free particle, Particle in a box 5. Hydrogen Atom in Wave Mechanics -Schrodinger equation in spherical coordinates, Radial probability densities,Zeeman effect	• Lecture • Demonstrations	• Assignment • Discussion • Simplifications	• To understand Schrodinger equation, Hydrogen atom	• Class test • Questioning

Faculty In-charge
Dr.Nijo Varghese & Dr. Salini Jose

PH5 B08: PHYSICAL OPTICS AND MODERN OPTICS

Semester: 5
Course Number:VIII
Number of hours of Lectures per week: 3
Number of Credits: 3
Number of Contact Hours: 56

Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

1. To give the idea about the basic Fermat's Principle
2. To empower students to understand the concept of interference
3. To understand the concept of diffraction.
4. To give a thorough understanding about holography and its applications
5. To acquire the basic knowledge Fibre optics

.

Prerequisites: Background of the basic science at +2 level

Course Outline

Unit 1

Fermat's Principle, verification of laws of reflection and refraction

Refraction and reflection by spherical surfaces : Refraction and reflection at a single spherical surfaces. The thin lens, The Principal Foci, and Focal length of a lens, The Newton formula, Lateral magnification.

Unit 2

2. Interference by division of wave front - Superposition of two sinusoidal waves, Interference, coherence ,conditions for interference, the interference patterns, intensity distribution .Fresnel's two mirror arrangement, Fresnel's Biprism, Determination of λ and $d\lambda$ of Sodium Light

3. Interference by division of amplitude - Interference by a plane film illuminated by a plane wave, cosine law, non reflecting films (the subsections excluded), interference by a film with two nonparallel reflecting surfaces, colours of thin films, Newton's rings, The Michelson interferometer, white light fringes-

Unit 3

4. Fraunhofer Diffraction - Preliminaries, single slit diffraction pattern, diffraction by circular aperture, limit of resolution, two slit Fraunhofer diffraction pattern, N slit diffraction pattern, plane diffraction grating, resolving power.

5. Fresnel Diffraction - Preliminaries, Fresnel half period zones, explanation of rectilinear propagation of light, zone plate

Unit 4

6. Polarization - Huygene's explanation of double refraction, positive and negative uniaxial crystals, quarter and half wave plates, types of polarized light, production and analysis of plane, circularly and elliptically polarized light, optical activity, Laurentz half shade polarimeter

Unit 5

7. Holography- Principles of holography, theory of construction and reconstruction of Hologram, Applications of Holography.

Unit 6

8. Fibre Optics - Optical fibre, Numerical aperture, step index fibre, pulse dispersion, graded index fibre, fibre optic sensors.

References

1. Optics by Ajoy Ghatak
2. Optics by Subramaniam, Brijlal & Avadhanulu – New edition
3. Optics by Mathur
4. Nonlinear Optics- B.B.Laud
5. Laser Fundamentals- Silfast
6. Wave Optics and its Applications – Rajpal S Sirohi – Orient Longman
7. Optical Communications – M Mukunda Rao – Universities Press
8. 8 Optics – Hetch and A RGanesan

COURSE OUTCOMES

CO1	Understand the fundamentals of Fermat's principles and geometrical optics
CO2	Understand and apply the basic ideas of interference of light
CO3	Understand and apply the basic ideas of diffraction of light
CO4	Understand the basics ideas of polarization of light
CO5	Describe the basic principles of holography and fibre optics

LESSON PLAN

Unit/ session/ hours (timerequire d)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (5 Hours)	1.Fermat's Principle, verification of laws of reflection and refraction, Refraction and reflection by spherical surfaces	• Lecture • Demonstrations • Numerical problem solving	• Assignment • Discussion • Simplifications	• To understand the Fermat's principle, refraction and reflection	• Class test • Questioning
UNIT II (14 Hours)	2. Interference by division of wave front - conditions for interference, the interference patterns, intensity distribution .Fresnel's two mirror arrangement, Fresnel's Biprism 3. Interference by division of amplitude - Interference by a plane film illuminated by a plane wave, cosine law, non reflecting films	• Lecture • Demonstrations	• Assignment • Discussion	• To understand the different concepts of interference	• Class test • Questioning
UNIT III (13 Hours)	4. Fraunhofer Diffraction- single slit diffraction pattern, diffraction by circular aperture, limit of resolution, two slit Fraunhofer diffraction pattern, 5. Fresnel Diffraction - Fresnel half period zones, explanation of	• Lecture • Demonstrations	• Assignment • Discussion	• To understand the fraunhofer diffraction and fresnel diffraction	• Class test • Questioning

	rectilinear propagation of light, zone plate				
UNIT IV (8 Hours)	6. Polarization -Huygene's explanation of double refraction, quarter and half wave plates,Laurentz half shade polarimeter	• Lecture • Demonstrations	• Assignment • Discussion	• To understand the concept of polarization	• Class test • Questioning
UNIT V (6 Hours)	7. Holography -Principles of holography, theory of construction and reconstruction of Hologram, Applications of Holography	• Lecture • Demonstrations	• Assignment • Discussion	• To understand the holography and its applications	• Class test • Questioning
UNIT VI (8 Hours)	8. Fibre Optics - Optical fibre, Numerical aperture, step index fibre, pulse dispersion, graded index fibre, fibre optic sensors.	• Lecture • Demonstrations	• Assignment • Discussion	• To understand the concepts of Fibre optics	• Class test • Questioning

Faculty In-charge
Dr. Salini Jose

PH5 B09: ELECTRONICS (ANALOG & DIGITAL)

Semester: 5
Course Number: IX
Number of hours of Lectures per week: 4
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal – 20 Marks + External – 80 Marks

OBJECTIVES

The objectives are to study

1. To give the idea about the basic principles of rectifiers and dc power supplies.
2. To empower students to understand the principles of transistors.
3. To prepare students to perform the designing of transistor amplifiers and oscillators.
4. To give a thorough understanding of the basic operation of Op –Amp and its applications.
5. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.

Prerequisites: Background of the basic science at +2 level

Course Outline

Unit 1

1. Semiconductor rectifiers and DC Power supplies - Preliminaries of rectification- Bridge rectifier- Efficiency- Nature of rectified output- Ripple factor- different types of filter circuits- voltage multipliers- Zener diode- voltage stabilization

2. Transistors - Different transistor amplifier configurations:- CB, CE, CC and their characteristics- amplification factors- their relationships- Load line Analysis- Expressions for voltage gain- current gain and power gain of C.E amplifier- cut-off and saturation points- Transistor biasing- Different types of biasing - Base resistor, voltage divider bias method- single stage transistor amplifier circuit- load line analysis- DC and AC equivalent circuits

3. Multistage Transistor amplifiers - R.C coupled amplifier- frequency response and gain in decibels- Transformer coupled Amplifiers -Direct Coupled Amplifier-Comparison

4. Feedback Circuits and Oscillators - Basic principles of feedback- negative feedback and its advantages- positive feedback circuits- Oscillatory Circuits-LC, RC oscillators- tuned collector oscillator- Hartley, Colpitt's, phase shift oscillators - their expressions for frequency

UNIT II

5. Digital Communication

Transmission and reception of radio waves, types of modulation, AM, FM their comparison advantages, demodulation, pulse code modulation

6. Special Devices and Opamp

LED, basic idea of UJT, FET, MOSFET, OP-amp: basic operation, application, inverting, Noninverting, summing amplifiers, Differentiator integrator

7. Number systems - Binary number system, conversions from one system to another (Binary, octal, Hexa decimal), Binary arithmetic, Compliments and its algebra.

8. Logic gates and circuits - Fundamental gates, Universal gates, De Morgan's theorem, Exclusive OR gate, Boolean relations, Half adder, Full adder, RS Flip Flop, JK Flip flop

Text books for study

1. Principles of electronics - VK Mehta - 2008 edition (S. Chand)
2. Introduction to Microprocessors - Aditya P Mathur (Tata McGarw Hill)
3. Digital principles and applications - Leach and Malvino (Tata McGraw Hill)

References

1. Digital Computer Fundamentals (Thomas.C. Bartee)
2. Electronics principles - Malvino
3. Physics of Semiconductor Devices- Second Edition – Dilip K Roy – Universities Press
4. Digital Fundamentals –Thomas L Floyd
5. Digital Technology-Principles and Practice-Virendrakumar
6. The Art of Electronics-Paul Herowitz & Winfield Hill
7. Electronic Principles and applications-A B Bhattacharya
8. Electronics-Classical and Modern-KAR

COURSE OUTCOMES

CO1	Understand the basic principles of rectifiers and dc power supplies
CO2	Understand the principles of transistor
CO3	Understand the working and designing of transistor amplifiers and oscillators
CO4	Understand the basic operation of Op – Amp and its applications
CO5	Understand the basics of digital electronics

LESSON PLAN

Unit/ session/ hours (timerequire d)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assess ment

UNIT I (34 Hours)	1. Semiconductor rectifiers and DC Power supplies - Bridge rectifier, different types of filter circuits- voltage multipliers- Zener diode 2. Transistors -CB, CE, CC, Load line Analysis, Transistor biasing- Different types of Biasing, single stage transistor amplifier circuit 3. Multistage Transistor amplifiers - R.C coupled amplifier, Transformer coupled Amplifiers -Direct Coupled Amplifier 4. Feedback Circuits and Oscillators - negative feedback and its advantages, positive feedback circuits- Oscillatory Circuits	• Lecture • Demonstrations • Numerical problem solving	• Assignment	To Understand the basic principles of rectifiers and dc power supplies To Understand the principles of transistor	• Test papers • Assignment • Quiz
UNIT II (38 Hours)	5. Digital Communication Transmission and reception of radio waves, types of modulation, AM, FM their comparison 6. Operational amplifier and its applications - OP-amp: basic operation, application7. Number systems- Binary number system, conversions	• Lecture • Demonstrations • Numerical problem solving	• Assignment • Discussion • Simplifications • Designing Circuits	• To Understand the basic operation of Op – Amp and its applications • To Understand the basics of digital electronics	• Evaluating Problem -Solutions • Test

	from one system to another 8. Logic gates and circuits - Fundamental gates, Universal gates, De Morgan’s theorem, Exclusive OR gate, Boolean relations, Half adder, Full adder, RS Flip Flop, JK Flip flop				

Faculty In-charge
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PH5 D01(1): NON CONVENTIONAL ENERGY SOURCES

Semester: 5
Course Number: Open course I
Number of hours of Lectures per week: 2
Number of Credits: 2
Number of Contact Hours: 36
Course Evaluation: Internal – 10 Marks + External – 40 Marks

OBJECTIVES

1. To Demonstrate the generation of electricity from various Non-Conventional sources of energy
2. To Estimate the solar energy, Utilization of it, Principles involved in solar energy collection and conversion of it to electricity generation.
3.To Explore the concepts involved in the wind energy conversion system by studying its components, types and performance.
4. To Illustrate ocean energy and explain the operational methods of their utilization.
5. To Acquire the knowledge on Geothermal energy.

Prerequisites: Background of the basic science at +2 level

Course Outline

Unit 1
Solar energy- Solar Energy Terms and Definitions- Solar Constant, Solar radiation measurements, Solar energy collector, Physical principle of the conversion of solar radiation in to heat, solar air heaters and drying, solar cookers, solar distillation, solar furnaces, solar greenhouses, solar power plants, solar photovoltaic cells(no need of mathematical equations)

Unit 2

Wind energy - Introduction, Utilisation aspects of wind energy, Advantages and Disadvantages of wind energy, Environmental impact of wind energy, Sources/Origins of wind, Principle of wind energy conversion and wind power, Basic components of wind energy conversion system(WECS), Advantages and Disadvantages of WECS, Wind-Electric Generating Power Plant, Wind Energy Economics, Problems in operating large wind power generators.

Unit 3

Geothermal energy- Introduction to Geothermal energy, Important aspects of Geothermal Energy, Structure of Earth's interior, Geothermal system-Hot Spring structure, Geothermal Resources (Hydrothermal, Geopressured, Petro-thermal system, Magma Resources), Advantages and disadvantages of geothermal energy over other energy forms, application of geothermal energy.

Energy from biomass: Introduction to biomass, Biomass resource, Biomass Conversion process (Densification, Combustion and incineration, Thermo Chemical conversion, Biochemical conversion), Biogas: Biogas Applications, Biogas Plants (Raw materials used, Main Components of a Biogas Plant)

Unit 4.

Energy from Oceans and Thermal and Chemical effects- Ocean Energy, Ocean Energy Sources, Tidal energy, Components of a Tidal Power Plant, Economic aspects of tidal energy conversion, Wave energy, Advantages and disadvantages, Factors affecting Wave energy, Ocean Thermal Energy Conversion (OTEC), Working principle of OTEC, Efficiency of OTEC, Types of OTEC Plants (Closed system, Thermoelectric OTEC system), Advantages and Disadvantages and Applications of OTEC. Thermo electric effects, Fuel Cells, Hydrogen energy, Nuclear Reactors, Advantages and Disadvantages of Nuclear power plants (Basic Principles/concepts only)

Text books:

1. Non – Conventional Energy Resources by G. D. Rai, Khanna Publishers, 2008.
2. Solar Energy Fundamentals and application by H.P. Garg and J. Prakash, Tata McGraw- Hill Publishing company ltd, 1997.
3. Solar energy by S. P. Sukhatme, Tata McGraw- Hill Publishing company ltd, 1997.
4. Solar energy by G.D. Rai, 1995.

References

1. Energy Technology by S. Rao and Dr. B.B. Parulekar, 1997, 2nd edition
2. Power Technology by A. K. Wahil. 1993.

COURSE OUTCOMES

CO1	Understand the importance of non conventional energy sources
CO2	Understand basic aspects of solar energy
CO3	Understand basic principles of wind energy conversion
CO4	Understand the basic ideas of geothermal and biomass energy and recognize their merits and demerits
CO5	Understand the basic ideas of oceans and chemical energy resources and recognize their merits and demerits

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (10 Hours)	Solar Constant, Solar radiation measurements, Solar energy collector, Physical principle of the conversion of solar radiation in to heat, solar air heaters and drying, solar cookers, solar distillation,	• Lecture • Demonstrations	• Assignment	To understand basic idea about solar energy	• Test papers • Assignment
UNIT II (7 Hours)	Principle of wind energy conversion and wind power, Basic components of wind energy conversion system(WECS), Advantages and Diadvantages of	• Lecture • Demonstrations	• Assignment	To acquire knowledge about wind energy	• Test papers • Assignment

	WECS, Wind-Electric Generating Power Plant, Wind Energy Economics,				
UNIT III (10 Hours)	Important aspects of Geothermal Energy, Structure of Earth's interior, Geothermal system-Hot Spring structure, Geothermal Resources, Energy from biomass: Introduction to biomass, Biomass resource, Biomass Conversion process	• Lecture • Demonstrations	• Assignment	To study important aspects of Geothermal energy	• Test papers • Assignment
UNIT IV (9 Hours)	Ocean Energy, Tidal energy, Wave energy, Ocean Thermal Energy Conversion(OTEC), Thermo electric effects, Fuel Cells, Hydrogen energy, Nuclear Reactors	• Lecture • Demonstrations	• Assignment • Discussion	To understand the concepts of OCean energy	• Test papers • Assignment

Faculty In-charge
Fency K F & Dr. Salini Jose

PH6 B10: THERMAL AND STATISTICAL PHYSICS

Semester: 6
Course Number: X
Number of hours of Lectures per week: 4
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal – 20 Marks + External – 80 Marks

Objectives

- To Become familiar with various thermodynamic processes and work done in each of these processes.
- To Have a clear understanding about Reversible and irreversible processes and also working of a Carnot engine, and knowledge of calculating change in entropy for various processes.
- To Realize the importance of Thermo dynamical functions and applications of Maxwell's relations.
- To Familiarize in depth about statistical distribution and have basic Ideas about Maxwell Boltzmann,Bose-Einstein and Fermi Dirac Statistics and their applications

Prerequisites: Background of the basic science at +2 level

Course Outline
Unit- I

Thermodynamic system- Thermal equilibrium-zeroth law-concept of heat and temperature - thermodynamic equilibrium- quasistatic process -extensive and intensive variables-thermodynamic process (cyclic and non cyclic)-indicator diagram- workdone in isothermal, adiabatic, isobaric and isochoric –cyclic processes- concept ofpath and point functions-internal energy- first law of thermodynamics-relation between P,T,V,in adiabatic process-slope of adiabatic and isothermal process -application of first law to heat capacities-(relation between Cp and Cv) and latent heat– adiabatic and isothermal elasticity of a gas)

UNIT 2
Reversible and irreversible processes , Conditions for reversibility-second law of thermodynamics-heat engine, Carnot engine, derivation for expression for efficiency, efficiency, Carnot's refrigerator-thermodynamic scale of temperature- Carnot's theorem and its proof.-application of second law(Clausius-Clapyron equation)- internal combustion engine-otto engine ,diesel engine -its efficiencies

UNIT 3
Entropy and adiabatics- definition of entropy-Change of entropy in a Carnot cycle-Change of entropy in an reversible cycle (Claussius theorem) -Change of entropy in an irreversible cycle (Claussius inequality)- Change in entropy of a perfect gas during a process-Change in entropy in a irreversible process-change in entropy due to free expansion-Change in entropy due to spontaneous cooling by conduction, radiation….etc, - Principle of increase of entropy-Entropy and available energy-Entropy and disorder-Nernst heat theorem entropy temperature diagrams

UNIT 4.

Thermodynamic functions-Enthalpy, Helmhlotz function, Gibbs function-Maxwell's thermodynamic relations-TdS relations-application of Maxwell's thermodynamical relations-1.variation of intrinsic energy with volume-2.Joule-Kelvin coefficient-3.Claussius-Clapeyron equation from Maxwell's thermodynamic relations- changes of phase.

UNIT 5

Statistical distributions-Maxwell-Boltzmann statistics (no derivation)-Distribution of molecular energies in an ideal gas-Average molecular energy- Equi partition theorem- Maxwell-Boltzmann speed distribution law-Expressions for rms speed, most probable speed and mean speed.

UNIT 6

Bose Einstein and Fermi Dirac distribution laws (no derivations)- Application of BE distribution law to black body radiation-Planck's radiation law-Stefan's law-Wien's displacement law-Fermi energy-Expression for Fermi energy of electron system-electron energy distribution- average electron energy at absolute zero-Degeneracy pressure and its astrophysical significance.

Text book of study

Heat and Thermodynamics by D S Mathur- Revised fifth edition)

References:

1. Heat and Thermodynamics-DS Mathur (V Edn.)
2. Statistical Mechanics – An Elementary Outline – Avijit Lahiri – Universities Press
3. Physics- Resnick and Halliday
4. Heat and Thermodynamics-Zemansky
5. Thermodynamics – Y V C Rao – Universities Press
6. Advanced Physics Second Edition – Keith Gibbs – Cambridge University Press
7. Thermodynamics and statistical mechanics-Brijlal Subramanium
8. Heat and Thermodynamics- A Manna

COURSE OUTCOMES

CO1	Understand the zero and first laws of thermodynamics
CO2	Understand the thermodynamics description of the ideal gas
CO3	Understand the second law of thermodynamics and its applications
CO4	Understand the basic ideas of entropy
CO5	Understand the concepts of thermodynamic potentials and phase transitions

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (18 Hours)	Zeroth Law and First Law of Thermodynamics - Thermal equilibrium and Zeroth Law, Intensive and extensive coordinates, PV diagram, Mathematical formulation of First Law, Differential form of the First Law	• Lecture • Demonstrations	• Assignment	To understand the laws of thermodynamics	• Test papers • Assignment
UNIT II (11 Hours)	Reversible and irreversible processes , Conditions for reversibility-second law of thermodynamics-heat engine, Carnot engine, derivation for expression for efficiency, efficiency, Carnot's refrigerator-thermodynamic scale of temperature- Carnot's theorem	• Lecture • Demonstrations	• Assignment	To acquire knowledge about Carnot engine	• Test papers • Assignment
UNIT III (14 Hours)	Entropy – Entropy of the ideal gas – TS diagram – Entropy and reversibility – Entropy and	• Lecture • Demonstrations	• Assignment	To study important aspects of entropy	• Test papers • Assignment

	irreversibility-Entropy and disorder – Exact differentials				
UNIT IV (10 Hours)	Thermodynamic Potentials and Phase Transitions - Enthalpy – Joule-Thomson expansion – Helmholtz and Gibbs functions, Maxwell's relations – TdS equations, First-order phase transitions, Clausius-Clapeyron equation and phase diagrams	• Lecture • Demonstrations	• Assignment	To understand basic idea about Enthalpy, Maxwell's reations	• Test papers • Assignment
UNIT V (8 Hours)	Statistical distributions-Maxwell-Boltzmann statistics (no derivation)-Distribution of molecular energies in an ideal gas-Average molecular energy	• Lecture • Demonstrations	• Assignment	To acquire knowledge about MB Statistics	• Test papers • Assignment
UNIT VI (11 Hours)	Bose Einstein and Fermi Dirac distribution laws (no derivations)-Application of BE distribution law to black body radiation-Planck's radiation law-Stefan's law-Wien's displacement law-Fermi energy-Expression for Fermi energy of electron system	• Lecture • Demonstrations	• Assignment	To study important aspects of BE and FD statistics	• Test papers • Assignment

Faculty In-charge
Fency K F

PH6 B11 : SOLID STATE PHYSICS, SPECTROSCOPY AND LASER PHYSICS

Semester: 6
Course Number: XI
Number of hours of Lectures per week: 4
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal – 20 Marks + External – 80 Marks

Objectives

- To Have a clear picture of crystal structures and a clear understanding about x-ray diffraction
- To gain knowledge of superconductivity,,its underlying principles and its applications in modern world
- To Become familiar with molecular spectroscopy and have gained basic ideas regarding microwave spectroscopy, infrared spectroscopy and Raman Spectroscopy.
- To gain basic knowledge of laser and working of different type of lasers

Prerequisites: Background of the basic science at +2 level

Course Outline

SOLID STATE PHYSICS

UNIT 1.Crystal Physics

Lattice Point & Space Lattice-Basis and crystal structure, unit cells and lattice Parameters, Unit cells v/s primitive cells, Crystal systems, crystal symmetry. The symmetry elements in a cubical crystal, rotation axis and inversion. Symmetry elements, Bravais space lattices-metallic crystal structure , sodium chloride, diamond, zinc sulphide, hexagonal and closed packed structure, directions, planes and Miller indices.

UNIT 2. X-ray Diffraction:

Bragg's law – Braggs X-ray spectrometer-Rotating Crystal method

UNIT 3. Super conductivity

A survey of superconductivity-Mechanism of Superconductors-Effects of Magnetic Field-Meissner Effect-isotope Effect-Energy Gap -Coherence Length- Josephson effect-BCS Theory (Qualitative idea only) -Application of Superconductivity, Type I and Type II superconductors.

MOLECULAR SPECTROSCOPY

UNIT 4 . Basic Elements of Spectroscopy
Quantum of Energy-Regions of Spectrum-Representation of Spectrum-Basic Elements of Practical Spectroscopy-Signal to Noise Ratio-Resolving Power-Width & Intensity of Spectral Transitions

UNIT 5. Microwave Spectroscopy
Classification of Molecules-Interaction of Radiation with Rotating Molecules-Rotational Spectrum of Rigid Diatomic Molecule-Example of CO-Selection Rule-Intensity-Spectrum of non –rigid Rotator-Example of HF- Spectrum of symmetric Top molecule- Example of Methyl chloride-Enformation derived from Rotational Spectrum.

UNIT 6. Infra Red Spectroscopy:
Vibrational Energy of an Anharmonic Oscillator-Diatomic Molecule (Morse Curve)-IR Spectra-Spectral Transitions & Selection Rules-Example of HCL-Vibration-Rotation Spectra of Diatomic Molecule-Born Oppenheimer Approximation-Instrmentation for Infra Red Spectroscopy

UNIT 7. Raman Spectroscopy
Raman Effect, Elements of Quantum theory & Applications-Pure Rotational Raman Spectrum-Examples of Oxygen and carbon-dioxide-Rotational Raman spectrum of symmetric Top molecule-Example of chloroform.Vibrational Raman spectrum of Symmetric Top Molecule-Example of Chloroform. (Molecular Structures & Spectroscopy by G Aruldhas &

UNIT 8. Laser Physics
Induced Absorption-Spontaneous Emission & Stimulated Emission-Einstein Coefficients Principle of Laser-Population inversion-Pumping-Properties of Laser-Types of Laser- Principle & working of Ruby laser, Helium Neon Laser & Semiconductor Laser- -Yag Lasers (Qualitative ideas only). Application of Lasers

Text Books for Study :

1. Solid State Physics by S O Pillai
2. Fundamentals of Molecular Spectroscopy by Banwell & Elaine M Mccash
3. Molecular Structure & Spectroscopy by G Aruldhas

References

1. Solid Sate Physics by M A Wahab
2. Introduction to Molecular Spectroscopy by G M Barrow
3. Raman Spectroscopy by Long D A
4. Modern Physics by R Murugeshan
5. Optical Communications – M Mukunda Rao – Universities Press
6. Principles of Condensed Matter Physics – P M Chaikin & T C Lubensky – Cambridge University Press

COURSE OUTCOMES

CO1	Understand the basic principles of statistical physics and its applications
CO2	Understand the basic aspects of crystallography in solid state physics
CO3	Understand the basic elements of spectroscopy
CO4	Understand the basics ideas of microwave and infra red spectroscopy
CO5	Understand the fundamental ideas of Laser physics

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (15 Hours)	Lattice Point & Space Lattice-Basis and crystal structure, unit cells and lattice Parameters, Unit cells v/s primitive cells, Crystal systems, crystal symmetry.	• Lecture • Demonstrations	• Assignment	To understand the Crystal structures	• Test papers • Assignment
UNIT II (5 Hours)	Bragg's law – Braggs X-ray spectrometer-Rotating Crystal method	• Lecture • Demonstrations	• Assignment	To acquire knowledge about X ray Diffraction	• Test papers • Assignment
UNIT III (8 Hours)	Mechanism of Superconductors-Effects of Magnetic	• Lecture • Demonstrations	• Assignment	To study important aspects of	• Test papers • Assignment

	Field- Meissner Effect-isotope Effect-Energy Gap -Coherence Length-Josephson effect-BCS			Superconductivity	
UNIT IV (5 Hours)	Quantum of Energy-Regions of Spectrum-Representation of Spectrum-Basic Elements of Practical Spectroscopy-Signal to Noise Ratio-Resolving Power-	• Lecture • Demonstrations	• Assignment	To understand basic idea about Spectroscopy	• Test papers • Assignment
UNIT V (8 Hours)	Microwave Spectroscopy- Bond length of CO Molecule,	• Lecture • Demonstrations	• Assignment	To understand basic idea about Microwave spectroscopy	• Test papers • Assignment
UNIT VI (9 Hours)	Infra Red Spectroscopy-Simple harmonic oscillator – Anharmonic oscillator, Born-Oppenheimer approximation	• Lecture • Demonstrations	• Assignment	To understand basic idea about Infrared spectroscopy	• Test papers • Assignment
UNIT VII (10 Hours)	Raman Effect, Elements of Quantum theory & Applications-Pure Rotational Raman Spectrum-Examples of Oxygen and carbon-dioxide-Rotational Raman spectrum of symmetric Top molecule	• Lecture • Demonstrations	• Assignment	To understand Raman Spectroscopy	• Test papers • Assignment

UNIT VIII (12 Hours)	Spontaneous Emission & Stimulated Emission-Einstein Coefficients Principle of Laser-Population inversion-Pumping-Properties of Laser-Types of Laser- Principle & working of Ruby laser, Helium Neon Laser	• Lecture • Demonstrations	• Assignment	To understand basic idea about Laser Physics	• Test papers • Assignment

Faculty In-charge
Dr.Salini Jose

PH6 B12 : NUCLEAR PHYSICS, PARTICLE PHYSICS & ASTROPHYSICS

Semester: 6
Course Number: XII
Number of hours of Lectures per week: 4
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal – 20 Marks + External – 80 Marks

Objectives

- To get a clear picture of nuclear composition and various nuclear models.
- To get deep knowledge about Radioactivity,nuclear Fission and Nuclear Fusion,the relevance of nuclear transformation.
- To Understand the working of nuclear detectors and counters,realize the importance of Cosmic rays and its effects on earth
- To familiarize with nuclear particles and different particle accelerators.
- To get Peripheral ideas about astronomy and astrophysics

Prerequisites: Background of the basic science at +2 level

Course Outline

UNIT: 1 Nuclear Structure

Nuclear composition – nuclear electrons – discovery of neutron, Nuclear properties – nuclear radii –spin and magnetic moment - nuclear magnetic resonance, Stable nuclei, Binding energy, Liquid drop model -semi empirical binding energy formula- mass parabolas, Shell model, Meson theory of nuclear forces – discovery of pion.

UNIT 2. Nuclear Transformations

Elementary ideas of radio activity- Alpha decay-tunnel theory of alpha decay-derivation for the formula for decay constant-Beta decay-negatron emission-positron emission electron capture -inverse beta decay and the discovery of neutrino, Gamma decay fundamental ideas of nuclear isomerism and internal conversion, The concept of interaction cross section--reaction rate-nuclear reactions-center of mass frame of reference and Q value of a nuclear reaction, Nuclear fission, Nuclear reactors-breeder reactors, Nuclear fusion-nuclear fusion in stars-proton-proton cycle-carbon nitrogen cycleformation of heavier elements, Fusion reactors-confinement methods.

UNIT 3. Nuclear Detectors And Counters

Interactions of radiation with matter – fundamental ideas, Gas filled counters- ionization chamber – proportional counter – G.M. counter, Cloud chamber, Bubble chamber, Semi conductor detectors and scintillation counters

UNIT 4. Cosmic Rays

Nature of Cosmic rays, the origin of cosmic rays, geomagnetic effects, Cosmic ray showers

UNIT 5. Particle Physics

Leptons –electron and positron-neutrinos and anti-neutrinos-other leptons, Hadronsresonance particles, Elementary particle quantum numbers-baryon number- lepton number - strangeness - isospin-electric charge-hyper charge-basic ideas on symmetries and conservation laws, Quarks -color and flavor, Fundamental interactions

UNIT 6. Particle Accelerators

Classification of accelerators-electrostatic accelerators-cyclic accelerators, the linear accelerator, the cyclotron, the betatron, the electron synchrotron .

UNIT 7. Astrophysics and astronomy

Stellar magnitudes an sequences, Absolute magnitude, The bolometric magnitude - Different magnitude standards, The colour index of a star, Luminosities of stars, Stellar parallax and the units of stellar distances, Stellar positions: The celestial co-ordinates. A Qualitative study on stellar positions and constellations

Text books for study

1. Concepts of Modern Physics – Arthur Beiser (5th Edition),
2. Nuclear Physics – Irving Kaplan (17.8)
3. Nuclear Physics-An Introduction: T.A. Littlefield and N. Thorley)
4. An introduction to AstroPhysics-Baidyanath Basu)

References

1. Nuclear Physics: D.G. Tayal
2. Atomic Physics: J.B. Rajam
3. Atomic Physics: John Yarwood
4. Introduction to Astrophysics: H L Duorah & Kalpana Duorah
5. Mayer – Jensen Shell Model and Magic Numbers: R Velusamy, Dec 2007
6. The Enigma of Cosmic Rays: Biman Nath, Resonance – Feb 2004, March 2004
7. Black body radiation: G.S. Ranganath, Resonance – Feb. 2008.
8. Advanced Physics Second Edition – Keith Gibbs – Cambridge University Press

COURSE OUTCOMES

CO1	Understand the basic aspects of nuclear structure and fundamentals of radioactivity
CO2	Describe the different types of nuclear reactions and their applications
CO3	Understand the principle and working of particle detectors
CO4	Describe the principle and working of particle accelerators
CO5	Understand the basic principles of elementary particle physics

LESSON PLAN

Unit/ session/ hours (timerequire d)	**Topics to be taught (input)**	**Procedur e (process) Student centric Method of teaching**	**Activity**	**Learning outcome (output)**	**Assessment**
UNIT I (12 Hours)	Nuclear Structure and Radioactivity - Liquid drop model – Shell model - Nuclear	• Lecture • Demonst rations	• Assign ment	To understand the Nuclear structures	• Test papers • Assignment

	force – Radioactive decay –Conservation laws in radioactive decay – Alpha decay – Beta decay – Gamma decay				
UNIT II (16 Hours)	.Nuclear Reactions and Applications -Fission – Fission reactors – Fusion – Fusion processes in stars – Fusion reactors – Applications of nuclear physics Semiconductor Counters – Spark Chamber – Cerenkov Counter	• Lecture • Demonst rations	• Assign ment	To acquire knowledge about Nuclear transformatio ns	• Test papers • Assignment
UNIT III (7 Hours)	Particle Detectors- Wilson Cloud Chamber – Bubble Chamber – Ionization Chambers– Proportional Counter – Geiger-Muller Counter – Scintillation Counters and I	• Lecture • Demonst rations	• Assign ment	To study important aspects of Particle detectors	• Test papers • Assignment
UNIT IV (4 Hours	Nature of Cosmic rays, the origin of cosmic rays, geomagnetic effects, Cosmic ray showers	• Lecture • Demonst rations	• Assign ment	To acquire knowledge about cosmic rays	• Test papers • Assignment
UNIT V (15 Hours	Elementary Particles - Particles and antiparticles – Families of particles – Conservation laws,	• Lecture • Demonst rations	• Assign ment	To understand the Particle physics	• Test papers • Assignment

	Particle interactions and decays – Resonance particles, The Quark Model – The Standard Mode				
UNIT VI (8 Hours	Classification of accelerators-electro static accelerators-cyclic accelerators, the linear accelerator, the cyclotron, the betatron, the electron synchrotron	• Lecture • Demonstrations	• Assignment	To study important aspects of particle accelerators	• Test papers • Assignment
UNIT VII (10 Hours	Stellar magnitudes an sequences, Absolute magnitude, The bolometric magnitude - Different magnitude standards, The colour index of a star, Luminosities of stars	• Lecture • Demonstrations	• Assignment	To understand the concepts of Astrophysics	• Test papers • Assignment

Faculty In-charge
Fency K F & Dr. Nijo Varghese

PH6 B13(E1): Elective- Computational Physics

Semester: 6
Course Number: XIII
Number of hours of Lectures per week: 3
Number of Credits: 3
Number of Contact Hours: 54
Course Evaluation: Internal – 20 Marks + External – 80 Marks

Objectives

- To get a clear picture of Python programming
- To get deep knowledge about Numerical methods in Physics

- To Introduce computational approach in Physics

Prerequisites: Background of the basic computer knowledge at +2 level

Course Outline
UNIT I.
Introduction to Python Programming:
Concept of high level language, steps involved in the development of a Program – Compilers and Interpreters - Introduction to Python language, Advantages of Python in comparison with other Languages - Different methods of using python: Using python as a calculator, Writing python programs and execution - Inputs and Outputs - Variables, operators, expressions and statements -- Strings, Lists, list functions (len, append, insert, del, remove, reverse, sort, +, *, max, min, count, in, not in, sum), sets, set functions(set, add, remove, in, not in, union, intersection, symmetric difference)-Tuples and Dictionaries, Conditionals, Iteration and looping - Functions and Modules - File input and file output, Pickling.

UNIT II.
Numerical Methods in physics
General introduction to numerical methods, Comparison between analytical and numerical techniques - Curve Fitting: Principle of least squares, fitting a straight line - Interpolation: Finite difference operator, Newton's forward difference interpolation formula, Solution of algebraic equations: Newton-Raphson method - Numerical differentiation and integration: Difference table, Trapezoidal and Simpson's (1/3) method - Solution of differential equations :Runge Kutta method (Second order) -Taylor's Series : Sin(x) and Cos(x).

UNIT III
Introduction to Computational approach in physics
One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium - Simulation of free fall and numerical integration, Two dimensional motion: Projectile motion (by Euler method)-Motion under an attractive Inverse Square- law force Accuracy considerations .

References:
1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website (http://www.altaway.com/resources/python/tutorial.pdf)
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, Newdelhi (or any other book)
7. Numerical methods for scientists and engineers, K. Sankara Rao, PHI

8. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall of India,1983)
9. Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,Darya Ganj,New Delhi-110 002
(For theory part and algorithms. Programs must be discussed in Python)

COURSE OUTCOMES

CO1	Introduction to programming language Python
CO2	Applying Numerical Methods in physics
CO3	Understanding Computational approach in physics

LESSON PLAN

Unit/ session/ hours (timerequired)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
UNIT I (20 Hours)	Introduction to Python language, Advantages of Python in comparison with other Languages - Different methods of using python: Using python as a calculator, Writing python programs and execution - Inputs and Outputs - Variables, operators, expressions and statements	• Lecture • Demonstrations • ComparativeStudy	• Assignment	To understand the Python Programming	• Test papers • Assignment
UNIT II (22 Hours)	Comparison between analytical and numerical techniques - Curve	• Lecture • Demonstrations	• Assignment	To acquire knowledge about Numerical methods in	• Test papers • Assignment

	Fitting: Principle of least squares, fitting a straight line - Interpolation: Finite difference operator, Newton's forward difference interpolation formula, Solution of algebraic equations: Newton-Raphson method			physics	
UNIT III (12 Hours)	Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium - Simulation of free fall and numerical integration, Two dimensional motion: Projectile motion	• Lecture • Demonst rations	• Assign ment	To study important aspects of computationa l methods in Physics	• Test papers • Assignment

Faculty In-charge
Dr. Nijo Varghese

PH6B14 - Practical II & PHY6B16: PRACTICAL III

Semester: 5 & 6
Course Number: XV & XVI
Number of hours of Lectures per week: 4
Number of Credits: 5
Number of Contact Hours:72 + 72
Course Evaluation: Internal – 30 Marks + External – 120 Marks

Objectives

- To Apply and illustrate the principles of semiconductor diode and transistor through experiments
- To Apply and illustrate the principles of transistor amplifier and oscillator through experiment
- To Apply and illustrate the principles of digital electronics through experiments
- To Analyze and apply computational techniques in Python programming

Prerequisites: Background of the basic practical knowledge at +2 level

Course Outline
Practical II
(Any 20)
1. Spectrometer- i1-i2 curve
2. Spectrometer-Cauchy's constants
3. Spectrometer-Diffraction Grating-Normal incidence
4. Laser-wavelength using transmission grating
5. Diffraction Grating-minimum deviation
6. Spectrometer-Quartz prism-Refractive indices of quartz for the ordinary and extraordinary rays
7. Newton's rings-wavelength of sodium light
8. Air wedge-angle of the wedge, radius of a thin wire
9. Lee's Disc –thermal conductivity
10. Potentiometer-calibration low range and high range voltmeters
11. Potentiometer- Reduction factor of TG
12. Variation of field with distance-Circular coil-moment of magnet & Bh
13. Carey Foster's bridge-resistance & resistivity
14. Carey Foster's bridge-Temperature coefficient of Resistance
15. Conversion of Galvanometer to voltmeter and calibrating using Potentiometer.
16. Conversion of Galvanometer to ammeter and calibrating using Potentiometer.
17. BG Absolute Capacity
18. BG-High resistance by leakage method
19. BG Mutual inductance
20. Planck's constant using LED's (3no.s)
21. Polarimeter-Specific rotation of sugar solution.
22. Searls and Box vibration magnetometers- m & Bh.
23. Numerical aperture of an optical fibre by semiconductor laser
24. Frequency of AC using sonometer

Practical III
Unit 1 (Any 15 experiments)

1. Construction of full wave, Centre tapped and Bridge rectifiers
2. Characteristics of Zener diode and construction of Voltage regulator.
3. Transistor characteristics and transfer characteristics in Common Base Configuration- current again
4. Transistor characteristics and transfer characteristics in Common Emitter Configuration- current again
5. CE Transistor Amplifier-Frequency response.
6. Full adder using NAND gates-construction & verification
7. Negative feedback amplifier
8. LC Oscillator (Hartley or Colpitts)
9. Phase shift oscillator

10. Operational Amplifier –inverting, non inverting, Voltage follower
11. LCR circuits-Resonance using CRO
12. Construction of basic gates using diodes(AND, OR) & transistors (NOT), verification by measuring voltages
13. Voltage multiplier (doubler, tripler)
14. Multivibrator using transistors.
15. Flip-Flop circuits –RS and JK using IC's
16. Verification of De-Morgan's Theorem using basic gates.
17. Half adder using NAND gates

Unit : II Numerical Methods Using Python :All programmes to be done.
18. Solution of equations by bisection and Newton-Raphson methods
19. Least square fitting – straight line fitting.
20. Numerical differentiation using difference table.
21. Numerical Integration – Trapezoidal and Simpson's 1/3 rd rule.
22. Taylor series - Sin θ, Cos θ
23. Solution of differential equation Runge-Kutta method (Harmonic Oscillator).
24. Simulation of freely falling body. Tabulation of position, velocity and acceleration as a function of time.
25. Simulation of projectile – Tabulation of position, velocity and acceleration as a function of time – Plot trajectory in graph paper from tabulated values

Books of Study:
1. Electronics lab manual- K A Navas (vol 1 &2)
2. B.Sc Practical Physics- C L Arora
3. Practical Physics- S L Gupta & V Kumar
4.Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books
5. Introductory methods of numerical analysis, S.S.Shastry , (Prentice Hall ofIndia,1983)
6.Introduction to Python for Engineers and Scientists by Dr.Sandeep Nagar, Apress publications.
7.Python for Education by Dr. B P Ajithkumar, IUAC, New Delhi; e-book freely downloadable from www.expeyes.in/documents/mapy.pdf

Reference Books:
1. Advanced Practical Physics for students – B L Worksnop and H T Flint

COURSE OUTCOMES

CO1	Apply and illustrate the principles of semiconductor diode and transistor through experiments

CO2	Apply and illustrate the principles of transistor amplifier and oscillator through experiments
CO3	Apply and illustrate the principles of digital electronics through experiments
CO4	Analyze and apply computational techniques in Python programming

LESSON PLAN

Experiments to be done (input)	Procedure (process) Student centric Method of teaching	Activity	Learning outcome (output)	Assessment
Practical II 1. Spectrometer-Cauchy's constants 2. Spectrometer-Diffraction Grating-Normal incidence 3. Laser-wavelength using transmission grating 4. Diffraction Grating-minimum deviation 5. Spectrometer-Quartz prism-Refractive indices of quartz for the ordinary and extraordinary rays 6. Newton's rings-wavelength of sodium light 7. Air wedge-angle of the wedge, radius of a thin wire 8. Lee's Disc –thermal conductivity 9. Potentiometer-calibration low range and high range voltmeters 10. Potentiometer-Reduction factor of TG	• Demonstrations • ComparativeStudy	• Assignment • Seminars	To get practical knowledge about Physics Experiments	• Practical exams • Assignment

11. Variation of field with distance-Circular coil-moment of magnet & Bh 12. Carey Foster's bridge-resistance & resistivity 13. Carey Foster's bridge-Temperature coefficient of Resistance 14. Conversion of Galvanometer to voltmeter and calibrating using Potentiometer. 15. BG Absolute Capacity 16. BG-High resistance by leakage method 18. Planck's constant using LED's (3no.s) 19. Polarimeter-Specific rotation of sugar solution. 20. Searls and Box vibration magnetometers- m & Bh. 21. Numerical aperture of an optical fibre by semiconductor laser 22. Frequency of AC using sonometer Construction of full wave, Centre tapped and Bridge rectifiers 2. Characteristics of Zener diode and construction of Voltage regulator. 3. Transistor characteristics and transfer characteristics in Common Base Configuration- current again 4. CE Transistor Amplifier-Frequency response.				

5. Full adder using NAND gates-construction & verification 6. Negative feedback amplifier 7. LC Oscillator (Hartley or Colpitts) 8. Phase shift oscillator 9. Operational Amplifier –inverting, non inverting, Voltage follower 10. Construction of basic gates using diodes(AND, OR) & transistors (NOT), verification by measuring voltages 11. Voltage multiplier (doubler, tripler) 12. Multivibrator using transistors. 13. Flip-Flop circuits –RS and JK using IC's 14. Verification of De-Morgan's Theorem using basic gates. 15. Half adder using NAND gates **Unit : II Numerical Methods Using Python** 16. Solution of equations by bisection and Newton-Raphson methods 17. Least square fitting – straight line fitting. 18. Numerical differentiation using difference table. 19. Numerical Integration – Trapezoidal and Simpson's 1/3 rd rule. 20. Taylor series - Sin θ, Cos θ				

21. Solution of differential equation Runge-Kutta method (Harmonic Oscillator). 22. Simulation of a freely falling body. Tabulation of position, velocity and acceleration as a function of time.				

Faculty In-charge
Fency K F, Dr. Nijo Varghese, Dr. Sr. Irene & Dr. Salini Jose

Department of Physics

Course Plan for Post Graduation in Physics (2019 Admissions onwards)

PHY1C01:CLASSICAL MECHANICS

Semester: 1
Course Number: 1
Contact Hours: 4T
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal & External: 1:4

Objectives of the Course:
To demonstrate knowledge and understanding of the following fundamental concepts in:

- the dynamics of system of particles,
- motion of rigid body,
- Lagrangian and Hamiltonian formulation of mechanics

To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics

Prerequisites: Background of the mechanics I at degree level.

Course Outline
1. Lagrangian and Hamiltonian Formulation:
Constraints and Generalized coordinates,D'Alembert's principle and Lagrange's equation, Velocity dependent potentials, Simple applications, Hamilton's Principle, Lagrange's equation from Hamilton's principle, Kepler problem,Scattering in a central force field, Transformation to lab coordinates, Legendre Transformation, Hamilton's canonical equations, Principle of least action, Canonical transformations, examples (17 hours)
Text : Goldstein, Sections 1.3 – 1.6, 2.1 – 2.3, 3.10, 3.11, 8.1, 8.5, 8.6, 9.1, 9.2

2. The classical background of quantum mechanics:
Equations of canonical transformations, Examples, Poisson brackets and other canonical invariants, Equation of motion in Poisson bracket form, Angular momentum Poisson brackets, Hamilton-Jacobi equation, Hamilton's principle and characteristic function, H-J equation for the linear harmonic oscillator, Separation of variables, Action-angle variables, H-J formulation of the Kepler problem, H-J equation and the Schrödinger equation. (19 hours)
Text : Goldstein, Sections 9.1, 9.2, 9.4 - 9.6, 10.1 – 10.5, 10.7, 10.8

3. The Kinematics and Dynamics of Rigid Bodies:
Space-fixed and body-fixed systems of coordinates, Description of rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation, Rate of change of a vector, Centrifugal and

Coriolis forces, Moment of inertia tensor, Euler’s equation of motion, Force free motion of a rigid bodies. (14 hours)
Text : Goldstein, Sections 4.1, 4.4, 4.8 – 4.10

4. Small Oscillations:
Formulation of the problem, Eigenvalue equation, Eigenvectors and Eigenvalues, Orthogonality, Principal axis transformation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear triatomic molecule.(9 hours)
Text : Goldstein, Sections 6.1 – 6.4

5. Nonlinear Equations and Chaos:
Introduction, Singular points of trajectories, Nonlinear oscillations, Limit cycles, Chaos : Logistic map,
Definitions, Fixed points, Period doubling, Universality. (13 hours)
Text : Bhatia, Sections10.1, 10.2, 10.3, 10.4, 10.5, 10.51

Textbooks :
1. Goldstein “Classical Mechanics” (Addison Wesley)
2. V.B.Bhatia : “Classical Mechanics” (Narosa Publications, 1997)
Reference books :
1. Michael Tabor : “Chaos and Integrability in Nonlinear Dynamics” (Wiley, 1989)
2. N.C.Rana and P.S.Joag : “Classical Mechanics” (Tata McGraw Hill)
3. R.G.Takwale and P.S.Puranik : “Introduction to Classical Mechanics” (Tata McGraw Hill)
4. Atam P. Arya : "Introduction to Classical Mechanics, (2nd Edition)" (Addison Wesley1998)
5. Laxmana : “Nonlinear Dynamics” (Springer Verlag, 2001)

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (17 hours)	Constraints and Generalized coordinates,D'Alembert's principle and Lagrange's equation, Velocity dependent potentials, Simple applications, Hamilton's Principle, Lagrange's equation from Hamilton's principle, Kepler problem, Scattering in a central force field, Transformation to lab coordinates, Legendre Transformation, Hamilton's canonical equations, Principle of least action, Canonical transformations, examples	● Lecture ●Problem-Solving	● To understand the idea of generalised coordinates. ● To establish the Lagrangian and to derive and solve the equations of motion for many systems subject to the principle of least action. ● To be familiar with Canonical and Legendre transformation	Evaluation of problems ● Q and A
Unit II (19hours)	Equations of canonical transformations, Examples, Poisson brackets and other canonical invariants, Equation of motion in Poisson bracket form, Angular momentum Poisson brackets, Hamilton-Jacobi equation, Hamilton's principal and characteristic function, H-J equation for the linear harmonic oscillator, Separation of variables, Action-angle variables, H-J formulation of the Kepler problem, H-J equation and the Schrödinger equation.	● Lecture ●Problem-Solving	● To understand the fundamentals of Hamilton's Jacobi theory. ● To acquire a deep knowledge of the Hamiltonian formalism that is crucial for the formulation and understanding of Quantum mechanics.	● problem solving ● Q and A

UnitIII (14 hours)	Space-fixed and body-fixed systems of coordinates, Description of rigid body motion in terms of direction cosines and Euler angles, Infinitesimal rotation, Rate of change of a vector, Centrifugal and Coriolis forces, Moment of inertia tensor, Euler's equation of motion, Force free motion of rigid bodies.	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● To get an idea on underlying kinematics and kinetics of Rigid body. ● To acquire a knowledge of inertia Tensor and Euyler's Equation of motion.	● Q & A ● Evaluation problem solving skill
Unit IV (9 hours)	Formulation of the problem, Eigenvalue equation, Eigenvectors and Eigenvalues, Orthogonality, Principal axis transformation, Frequencies of free vibrations, Normal coordinates, Free vibrations of a linear triatomic molecule.	● Lecture ●Problem-Solving ● Seminar	● To establish eigenvalue and eigenvectors of small oscillations ● To describe and understand the vibrations of discrete and continuous mechanical systems.	● Q & A ● Evaluation problem solving skill
Unit V (13hours)	Introduction, Singular points of trajectories, Nonlinear oscillations, Limit cycles, Chaos : Logistic map, Definitions, Fixed points, Period doubling, Universality.	●Lecture ●Problem-Solving ● Seminar	● To predict the chaotic behaviour existing in natural systems. ● To visualise the logistic map and bifurcation.	● Q & A ● Evaluation problem solving skill

Faculty In-charge
Ms. Ancy Maria Varghese

PHY1C02:MATHEMATICAL PHYSICS-I

Semester: 1
Course Number: 2
Contact Hours: 4 T
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal & External: 1:4

Objectives of the Course:

- The laws of Physics are often expressed through the relatively complex mathematical apparatus. This course is intended to give mathematical tools necessary for better understanding of the later courses in physics such as classical mechanics, electrodynamics, quantum mechanics,solid state Physics and statistical physics.

Prerequisites: Background of the basic mathematics at +2 and degree level

Course Outline

1. Vectors :
Rotation of coordinates, Orthogonal curvilinear coordinates, Gradient, Divergence and Curl in orthogonal curvilinear coordinates, Rectangular, cylindrical and spherical polar coordinates, Laplacian operator, Laplace's equation –application to electrostatic field and wave equations, Vector integration, Enough exercises. (11 hours)
Text : Arfken & Weber , Sections 1.2, 1.6 - 1.9, 1.10, 2.1 – 2.5

2. Matrices and Tensors :
Basic properties of matrices (Review only), Orthogonal matrices, Hermitian and Unitary matrices, Similarity and unitary transformations, Diagonalization of matrices, Definition of Tensors, Contraction, Direct products,, quotient rule, Pseudo tensors, Dual tensors, Levi Cevita symbol, irreducible tensors, Enough exercises. (11 hours)
Text : Arfken & Weber , Sections 3.2 - 3.5, 2.6 – 2.9

3. Second Order Differential Equations:
Partial differential equations of Physics, Separation of variables, Singular points, Ordinary series solution,Frobenius method, A second solution, Self adjoint differential equation, eigen functions and values, Boundary conditions,Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions, Enough exercises. (14hours)
Text : Arfken & Weber , Sections 8.1, 8.3 – 8.6, 9.1 – 9.4

4. Special functions :
Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions of the first and second kinds, Generating function, Recurrence relation, Orthogonality, Neumann function,

Spherical Orthogonality, Associated Legendre polynomials, Spherical harmonics, Hermite polynomials, Laguerre polynomials.
Text : Arfken & Weber , Sections 10.1, 10.4, 1.15, 11.1 – 11.3, 11.7, 12.1 – 12.4, 12.6, 13.1, 13.2

5. Fourier Series :
General properties, Advantages, Uses of Fourier series, Properties of Fourier series, Fourier integral, Fourier transform, Properties, Inverse transform, Transform of the derivative, Convolution theorem, Laplace transform, Enough exercises. (12 hours)
Text : Arfken & Weber , Sections 14.1 – 14.4, 15.2 – 15.5, 15.8
Text book :
1. G.B.Arfken and H.J.Weber : "Mathematical Methods for Physicists (5th Edition, 2001)" (Academic Press)

Reference books :
1. J.Mathews and R.Walker : "Mathematical Methods for Physics" (Benjamin)
2. L.I.Pipes and L.R.Harvill : "Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. A.W. Joshi : Matrices and tensors
6. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
7. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
8. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

Course Plan

Unit/hours (time required)	**Topics to be taught (input)**	**Procedure (process) Student centric Method of teaching**	**Activity Learning outcome(output)**	**Assessment**
Unit I (11hours)	Rotation of coordinates, Orthogonal curvilinear coordinates, Gradient, Divergence and Curl in orthogonal curvilinear coordinates, Rectangular, cylindrical and spherical polar coordinates, Laplacian operator, Laplace's equation – application to electrostatic field and wave equations, Vector integration, Enough exercises.	● Lecture ●Problem-Solving	● To understand the concept of coordinate system and describe orthogonal curvilinear coordinates. generalised coordinates. ● To describe Laplace's equation and its application to electrostatic fields.	Evaluation of problems ● Q and A
Unit II (11hours)	Basic properties of matrices (Review only), Orthogonal matrices, Hermitian and Unitary matrices, Similarity and unitary transformations, Diagonalization of matrices, Definition of Tensors, Contraction, Direct products,, quotient rule, Pseudo tensors, Dual tensors, Levi Cevita symbol, irreducible tensors, Enough exercises.	● Lecture ●Problem-Solving	● To learn about special types of matrices that are relevant in physics. ● To acquire a deep knowledge about tensors.	● problem solving ● Q and A

Unit III (14 hours)	Partial differential equations of Physics, Separation of variables, Singular points, Ordinary series solution, Frobenius method, A second solution, Self adjoint differential equation, eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions, Enough exercises.	●Lecture ●Problem-Solving	● To learn different ways of solving second order differential equations and familiarise with singular points and frobenius method ● To acquire knowledge on schmidt orthogonalization.	● Q & A ● Evaluation problem solving skill
Unit IV (24 hours)	functions : Gamma function, Beta function, Delta function, Dirac delta function, Bessel functions of the first and second kinds, Generating function, Recurrence relation, Orthogonality, Neumann function, Spherical Bessel function, Legendre polynomials, Generating function, Recurrence relation, Rodrigues" formula, Orthogonality, Associated Legendre polynomials, Spherical harmonics, Hermite polynomials, Laguerre polynomials, Enough exercises.	● Lecture ●Problem-Solving	● To get introduced to special functions like gamma ,beta and delta functions,dirac delta function,Bessel Function and their recurrence relations.	● Q & A ● Evaluation problem solving skill

Unit V (13hours)	General properties, Advantages, Uses of Fourier series, Properties of Fourier series, Fourier integral, Fourier transform, Properties, Inverse transform, Transform of the derivative,convolution theorem, Laplace transform, Enough exercises.	●Lecture ●Problem-Solving ● Seminar	● To use the fourier series and integral. ● To understand the transformations in fourier and laplace transforms..	● Q & A ● Evaluating through internal exams

Faculty In-charge
Ms.Sukanya I S

PHY1C03:ELECTRODYNAMICS AND PLASMA PHYSICS

Semester: 1
Course Number: 3
Contact Hours: 4T
Number of Credits: 4
Number of Contact Hours: 72 Hrs.
Course Evaluation: Internal & External: 1:4

Objectives of the Course:
· This subject provides an introduction to electrodynamics and a wide range of applications including communications,plasmas.

Prerequisites: Background of the electrostatics and electrodynamics at degree level

Course Outline

1. Time varying fields and Maxwell's equations :
Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Time harmonic fields, Multipole expansion of electric scalar potential and magnetic vector potential, Enough exercises. (14 hours)
Text : Cheng, Sections 7.3 – 7.7, Griffiths, Sections 3.4, 5.4.2

2. Plane electromagnetic waves :
Plane waves in lossless media, Plane waves in lossy media, Group velocity, Flow of electromagnetic power and the Poynting vector, Normal incidence at a plane conducting boundary, Oblique incidence

at a plane conducting boundary, Normal incidence at a plane dielectric boundary, Oblique incidence at a plane dielectric boundary, Enough exercises. (13 hours)
Text : Cheng , Sections 8.2 – 8.10

3. Transmission lines, Waveguides and cavity resonators:
Transverse electromagnetic waves along a parallel plane transmission line, General transmission line equations,Wave characteristics on finite transmission lines, General wave behaviour along uniform guiding structures, Rectangular waveguides, Cavity resonators (Qualitative ideas only), Enough exercises. (14 hours)
Text : Cheng, Sections 9.2 - 9.4 , 10.2, 10.4, 10-7.1

4. Relativistic electrodynamics:
Magnetism as a relativistic phenomenon, Transformation of the field, Electric field of a point charge moving uniformly, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics, Enough exercises. (15 hours)
Text : Griffiths, Sections 10.3.1 – 10.3.5

5. Plasma Physics :
Plasma - Definition, concepts of plasma parameter, Debye shielding, Motion of charged particles in an
electromagnetic field - Uniform electric and magnetic fields, Boltzmann and Vlasov equations, their moments - Fluid equations, Plasma oscillations, Enough exercises. (16 hours)
Text : Chen, Sections 1.1 - 1.6, 2.2 - 2.2.2, 3.1 - 3.3.2, 4.3, 4.18, 4.19, 7.2-7.3

Text books :

1. David K. Cheng : “ Field and Wave Electromagnetics (Addisson Wesley)
2. David Griffiths : “ Introductory Electrodynamics” (Prentice Hall of India, 1989)
3. F. F. Chen, Introduction to Plasma Physics and Controlled Fusion, Volume I and II,
Plenum Press, recent edition

Reference books :

1. K.L. Goswami, Introduction to Plasma Physics – Central Book House, Calcutta
2. J.D.Jackson : “Classical Electrodynamics” (3rd Ed.) (Wiley,1999)

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (14hours)	Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and their solutions, Time harmonic fields, Multipole expansion of electric scalar potential and magnetic vector potential, Enough exercises. cises.	● Lecture ●Problem-Solving	● To explain classical electrodynamics based on Maxwell's equations including its formulation in covariant form. ● To gain a clear understanding of electromagnetics boundary conditions.	Evaluation of problems ● Q and A
Unit II (13hours)	Plane waves in lossless media, Plane waves in lossy media, Group velocity, Flow of electromagnetic power and the Poynting vector, Normal incidence at a plane conducting boundary, Oblique incidence at a plane conducting boundary, Normal incidence at a plane dielectric boundary, Oblique incidence at a plane dielectric boundary, Enough exercises.	● Lecture ●Problem-Solving	● To know that the laws of reflection,refraction are outcomes of electromagnetic boundary conditions ● Able to design dielectric coatings which act like antireflection coating and able to distinguish good metal and dielectric.	● problem solving ● Q and A

Unit III (14hours)	Transverse electromagnetic waves along a parallel plane transmission line, General transmission line equations, Wave characteristics on finite transmission lines, General wave behaviour along uniform guiding structures, Rectangular wave guides, Cavity resonators (Qualitative ideas only), Enough exercises. .	●Lecture ●Problem-Solving	● To grasp the idea of electromagnetic wave propagation through waveguides and transmission lines..	● Q & A ● Evaluatio n problem solving skill
Unit IV (15hours)	Magnetism as a relativistic phenomenon, Transformation of the field, Electric field of a point charge moving uniformly, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics, Enough exercises.	● Lecture ●Problem-Solving	● To extend their understanding of special theory of relativity by including relativistic electrodynamic s	● Q & A ● Evaluatio n problem solving skill
Unit V (16hours)	Plasma - Definition, concepts of plasma parameter, Debye shielding, Motion of charged particles in an electromagnetic field - Uniform electric and magnetic fields, Boltzmann and Vlasov equations, their moments - Fluid equations, Plasma oscillations, Enough exercises.	●Lecture ●Problem-Solving ● Seminar	● To understand rather complex physical phenomena observed in plasma.	● Q & A ● Evaluatin g through internal exams

Faculty In-charge
Ms.Sukanya I S

PHY1C04:ELECTRONICS

Semester:1
Course Number: 4
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: Integrates the understanding and creation of modern electronic designs and systems.

Prerequisites:
· Knowledge of analog and digital electronics in degree level.

Course Outline:

1 .Field effect transistors : V-I characteristics of JFETs and device operation, construction of depletion and enhancement MOSFETs, V-I characteristics and device operation. Biasing of FETs, FETs as VVR and its applications, small signal model of FETs, analysis of Common Source and Common Drain amplifiers at low and high frequencies, MOSFET as a switch,CMOS and digital MOSFET gates (NOT, NAND, NOR). (10 hours)
Text: Integrated Electronics Millman and Halkias: Tata McGraw Hill
Reference:
Electronic devices and Circuit theory, Robert L Boylstead& L. Nashelsky – Pearson education
Micro Electronic Circuits: Sedra/Smith: Oxford University Press

2. Microwave and Photonic devices:
Tunnel diode, construction and characteristics, negative differential resistance and device operation, radiative transitions and optical absorption, Light emitting diodes (LED) – visible and IR, semiconductor lasers,construction and operation, population inversion, carrier and optical confinement, optical cavity and feedback,threshold current density. Photodetectors – Photoconductor (Light dependent resistor- LDR) and photodiode,p-n junction solar cells - short circuit current, fill factor and efficiency (14 hours)
Text: Semiconductor Devices- Physics and Technology - S.M.Sze, John Wiley and Sons
Semiconductor Optoelectronic devices: Pallab Bhattacharya: Prentice Hall
Reference:
Principles of semiconductor devices: B. Van Zeghbroeck
Principles of semiconductor devices: S.M. Sze: John Wiley & Sons

3. Operational Amplifier: Differential amplifiers, analysis of Emitter coupled differential amplifiers, OPAMP parameters:Open loop gain,CMRR, error currents and error voltages, input and output

impedances, slew rate and UGB. Frequency response, poles and zeros; transfer functions (derivation not required), expression for phase angle. Need for compensation,
dominant pole, pole zero and lead compensation (12 hours)
Text: Integrated Electronics: Millman and Halkias: Tata McGraw Hill
Reference:
OPAMPS and Linear Integrated Circuits: Ramakant A. Gaykwad

4. OPAMP Applications: Closed loop inverting, non-inverting and difference OPAMP configurations and their characteristics; OPAMP as inverter, scale changer, summer, V to I converter, practical integrator & differentiator, active low pass , high pass and band pass Butterworth filters, band pass filter with multiple feedback, OPAMP notch filter, OPAMP Wien bridge oscillator, OPAMP astable and monostable multivibrators, Schmidt triggers. (14 hours)
Text: Integrated Electronics:Millman and Halkias : Tata McGraw Hill
OPAMPS and Linear Integrated Circuits: Ramakant A. Gaekwad
Reference:
Linear Integrated circuits:D. Roychoudhuri : New Age International Publishers

5. Digital Electronics: Minimization of Boolean functions using Karnaugh map and representation using logic gates, JK and MSJK andD flip-flops, shift registers using D and JK flip flops and their operations, shift registers as counters, ring counter, design of synchronous and asynchronous counters, state diagram,cascade counters, basic idea of static and dynamic RAM,basics of charge coupled devices. R-2R ladder D/A converter, Introduction to 8 bit microprocessor; internal architecture of Intel 8085, register organisation. (22 hours)
Text:
Digital Principles and Applications: Malvino and Leach: Tata McGraw Hill
Digital Fundamentals: Thomas. L. Floyd: Pearson Education.
Fundamentals of Microprocessors and Microcomputers: B. Ram: DhanpatRai & Sons.
Reference:
Modern Digital Electronics: R.P. Jain: Tata McGraw Hill

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (10hours)	V-I characteristics of JFETs and device operation, construction of depletion and enhancement MOSFETs, V-I characteristics and device operation. Biasing of FETs, FETs as VVR and its applications, small signal model of FETs, analysis of Common Source and Common Drain amplifiers at low and high frequencies, MOSFET as a switch, CMOS and digital MOSFET gates (NOT, NAND, NOR). .	● Lecture ●Problem-Solving	● To get an idea on field effect transistors,their principles and applications. ● To know about CMOS and digital MOSFET gates.	Evaluation of problems ● Q and A
Unit II (14hours)	Tunnel diode, construction and characteristics, negative differential resistance and device operation, radiative transitions and optical absorption, Light emitting diodes (LED) – visible and IR, semiconductor lasers, construction and operation, population inversion, carrier and optical confinement, optical cavity and feedback, threshold current density. Photodetectors – Photoconductor (Light dependent resistor- LDR) and photodiode,	● Lecture ●Problem-Solving ● Seminar	● To understand the concept of photonic devices like LED,laser diode,Photodetector,solar cell and their working in detail..	● problem solving ● Q and A

	p-n junction solar cells - short circuit current, fill factor and efficiency			

UnitIII (12hours)	Differential amplifiers, analysis of Emitter coupled differential amplifiers, OPAMP parameters: Open loop gain,CMRR, error currents and error voltages, input and output impedances, slew rate and UGB. Frequency response, poles and zeros; transfer functions (derivation not required), expression for phase angle. Need for compensation, dominant pole, pole zero and lead compensation	●Lecture ●Problem-Solving	● To grasp the idea of Operational amplifiers,opamp parameters. ● To know about AC and DC characteristics of OPAMP and need for frequency compensation.	● Q & A ● Evaluation on problem solving skill
Unit IV (14hours)	Closed loop inverting, non-inverting and difference OPAMP configurations and their characteristics; OPAMP as inverter, scale changer, summer, V to I converter, practical integrator & differentiator, active low pass , high pass and band pass Butterworth filters, band pass filter with multiple feedback, OPAMP notch filter, OPAMP Wien bridge oscillator, OPAMP astable and monostable multivibrators, Schmidt triggers.	● Lecture ●Problem-Solving	● To extend their understanding of OPAMP applications as inverter,integrator,Differentiator, monostable and astable multivibrator etc.	● Q & A ● Evaluation on problem solving skill

Unit V (22hours)	Minimization of Boolean functions using Karnaugh map and representation using logic gates, JK and MSJK andD flip-flops, shift registers using D and JK flip flops and their operations, shift registers as counters, ring counter, design of synchronous and asynchronous counters, state diagram,cascade counters, basic idea of static and dynamic RAM, basics of charge coupled devices. R-2R ladder D/A converter, Introduction to 8 bit microprocessor; internal architecture of Intel 8085, register organisation.	● Lecture ● Problem-Solving ● Seminar	● Digital electronics discussing logic gates and representation using K Maps. ● To acquire knowledge about Flip Flops,shift registers and counters. ● To have an understanding on intel 8085 microprocessor and its architecture.	● Q & A ● Evaluating through internal exams

Faculty In-charge
Ms.Shyama I

PHY2C05:QUANTUM MECHANICS-I

Semester:2
Course Number: 1
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course:

Prerequisites: · Background of quantum mechanics in degree level.

Course Outline:

1.Formulation of Quantum Mechanics (20 hours)
Sequential Stern-Gerlach experiments – Analogy with the polarization of light – Need for representing a quantum mechanical state as a vector in complex vector space. Dirac notation – Ket space, Bra space and Inner products – Operators– Hermitian adjoint – Hermitian operator – Multiplication – Associative axiom – Outer product. Eigenkets and eigenvalues of Hermitian operator – Eigenkets as base kets – Completeness relation – Projection operator – Matrix representation of operators, kets and bras. Measurement in a quantum mechanical system – Expectation value –Illustration with spin-½ systems – Compatible observables and simultaneous eigenkets – Maximal set of commuting observables – Incompatible observables and general uncertainty relation. Unitary operator – Change of basis and transformation matrix – Similarity transformation – Diagonalization – Unitary equivalent observables. Position eigenkets and position measurements –Infinitesimal translation operator and its properties – Linear momentum as a generator of translation – Canonical commutation relations. Position-space wave function – wave function as an expansion coefficient – Momentum operator in the position basis – Momentum-space wavefunction – Transformation function or the momentum eigenfunction in position basis –Relations between wavefunctions in position-space and momentum-space. Gaussian wave packet – Computation of dispersions of position operator and momentum operator – Minimum uncertainty product. Generalization to three dimensions.
Text: Chapter 1, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai

2.Quantum Dynamics (20 hours)
Time-evolution operator – Schrodinger equation for the time-evolution operator and its solutions according to the time-dependence of the Hamiltonian operator –Energy eigenkets – Time dependence of expectation values – Time evolution of a spin-1/2 system and Spin precession –

Correlation amplitude and energy-time uncertainty relation. Schrodinger picture and Heisenberg picture – Behaviour of state kets and observables in Schrodinger picture and Heisenberg picture – Heisenberg equation of motion – Ehrenfest's theorem. Time-evolution of base kets and transition amplitudes. Simple harmonic oscillator – energy eigenkets and energy eigenvalues – Dirac's method – Time development of the oscillator. Schrodinger's wave equation – Time-dependent wave equation – Time-independent wave equation – Continuity Equation – Interpretations
of the wavefunction – Classical limit of wave mechanics. Boundary conditions – Elementary solutions to Schrodinger's wave equation – Free particle in one dimension and three dimensions – Simple harmonic oscillator – Particle in a one-dimensional box – Particle in a finite potential well – One-dimensional potential step – Square potential barrier.
Text ::(1) Chapter 2 – upto section 2.5, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai
(2) Chapter 4 – section 4.3, Quantum Mechanics (Edn.4) by V. K. Thankappan

3.Theory of Angular Momentum (15 hours)
Non-commutative nature of rotations around different axes – Rotation operator – Infinitesimal rotations in quantum mechanics – Fundamental commutation relations for angular momentum operators. Rotation operators for spin-1/2 systems– Spin precession in a magnetic field – Pauli's two component formalism – Representation of the rotation operator as 2 x 2matrix. Ladder operators and their commutation relations – Eigenvalue problem for angular momentum operators J2 and Jz–Matrix elements of angular momentum operators and rotation operator. Orbital angular momentum – Orbital angular momentum as generator of rotation – Spherical harmonics – Spherical harmonics as rotation matrices. Addition of orbital angular momentum and spin angular momentum – Addition of angular momenta of two spin-1/2 particles – Formal theory of Angular Momentum addition – Computation of Clebsch-Gordan coefficients – Clebsch-Gordan coefficients and the rotation matrices.
Text : Chapter 3 – sections 3.1, 3.2, 3.5, 3.6 and 3.8, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai

4.Central Potentials (8 hours)
Schrodinger's equation for central potentials – The radial equation – Particle in an infinite spherical well – Isotropic harmonic oscillator – The Coulomb potential and the hydrogen atom problem.
Text : Chapter 3 – section 3.7, Modern Quantum Mechanics (Edn.2) by J. J. Sakurai.

5.Invariance Principles and Conservation Laws (9 hours)
Symmetry and conservation laws –Space-time symmetries – Displacement in space and conservation of linear momentum –Displacement in time and conservation of energy – Rotation in space and conservation of angular momentum – Space inversion and conservation of parity – Time reversal symmetry. The indistinguishability principle – Symmetric and antisymmetric wave functions – Eigenvalues and eigenvectors of particle-exchange operator – Spin and statistics – Pauli's exclusion principle and antisymmetric wave function – The ground state of the Helium atom.
Text: Chapter 6 and 9 – relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan
Textbooks :

1. Modern Quantum Mechanics (Edn.2) : J. J. Sakurai, Pearson Education.
2.Quantum Mechanics (Edn.4) : V. K. Thankappan, New Age International

References:

1. Principles of Quantum Mechanics (Edn.2) : R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education .
3. Introduction to Quantum Mechanics (Edn.2) : D.J. Griffiths, Pearson Education.
4. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.
5. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M.
Lifshitz, Pergamon Press.
6. The Feynman Lectures on Physics Vol. 3, Narosa .
7. Quantum Mechanics : Concepts and Applications (Edn.2) : Nouredine Zettili, Wiley.
8. Quantum Mechanics Demystified: David McMohan, McGrawHill 2006.
9. Quantum Mechanics (Schaum's Outline) :Yoav Pelegetal. Tata McGraw Hill Private Limited, 2/e.
10. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.

Course Plan

Unit/hours (time required)	**Topics to be taught (input)**	**Procedure (process) Student centric Method of teaching**	**Activity Learning outcome(output)**	**Assessment**
Unit I (20hours)	Sequential Stern-Gerlach experiments – Analogy with the polarization of light – Need for representing a quantum mechanical state as a vector in complex vector space. Dirac notation – Ket space, Bra space and Inner products – Operators– Hermitian adjoint – Hermitian operator – Multiplication – Associative axiom – Outer product. Eigenkets and eigenvalues of Hermitian operator – Eigenkets as base kets – Completeness relation –	● Lecture ●Problem-Solving	● To understand linear vector space,Hilbert's space,concept of basis and operators and bra and ket notation. ● To describe Momentum and position representation.	Evaluation of problems ● Q and A

	Projection operator – Matrix representation of operators, kets and bras. Measurement in a quantum mechanical system – Expectation value –Illustration with spin-½ systems – Compatible observables and simultaneous eigenkets – Maximal set of commuting observables – Incompatible observables and general uncertainty relation. Unitary operator – Change of basis and transformation matrix – Similarity Transformation – Diagonalization – Unitary equivalent observables. Position eigenkets and position measurements –Infinitesimal translation operator and its properties – Linear momentum as a generator of translation – Canonical commutation relations. Position-space wave function – wave function as an expansion coefficient – Momentum operator in the position basis – Momentum-space wavefunction – Transformation function or the momentum eigenfunction in position basis –Relations between wavefunctions in position-space and momentum-space. Gaussian wave packet – Computation of dispersions of position operator and momentum operator – Minimum uncertainty product. Generalization to three dimensions. .			

Unit II (20hours)	Time-evolution operator – Schrodinger equation for the time-evolution operator and its solutions according to the time-dependence of the Hamiltonian operator –Energy eigenkets – Time dependence of expectation values – Time evolution of a spin-1/2 system and Spin precession – Correlation amplitude and energy-time uncertainty relation. Schrodinger picture and Heisenberg picture – Behaviour of state kets and observables in Schrodinger picture and Heisenberg picture – Heisenberg equation of motion – Ehrenfest's theorem. Time-evolution of base kets and transition amplitudes. Simple harmonic oscillator – energy eigenkets and energy eigenvalues – Dirac's method – Time development of the oscillator. Schrodinger's wave equation – Time-dependent wave equation – Time-independent wave equation – Continuity Equation – Interpretations of the wavefunction – Classical limit of wave mechanics. Boundary conditions – Elementary solutions to Schrodinger's wave equation – Free particle in one dimension and three dimensions – Simple harmonic oscillator – Particle in a one-dimensional box – Particle in a finite potential well – One-dimensional potential step – Square potential barrier.	• Lecture • Problem-Solving • Seminar	• To understand the concept of both schrodinger and Heisenberg formulations of time development and their applications.	• problem solving • Q and A

Unit III(15hours)	Non-commutative nature of rotations around different axes – Rotation operator – Infinitesimal rotations in quantum mechanics – Fundamental commutation relations for angular momentum operators. Rotation operators for spin-1/2 systems– Spin precession in a magnetic field – Pauli's two component formalism – Representation of the rotation operator as 2 x 2matrix. Ladder operators and their commutation relations – Eigenvalue problem for angular momentum operators J2 and Jz–Matrix elements of angular momentum operators and rotation operator. Orbital angular momentum – Orbital angular momentum as generator of rotation – Spherical harmonics – Spherical harmonics as rotation matrices. Addition of orbital angular momentum and spin angular momentum – Addition of angular momenta of two spin-1/2 particles – Formal theory of Angular Momentum addition – Computation of Clebsch-Gordan coefficients – Clebsch-Gordan coefficients and the rotation matrices	●Lecture ●Problem-Solving	● To grasp the idea theory of angular momentum ans spin matrices. ● To know about orbital angular momentum and Clebsch -Gordan coefficients.	● Q & A ● Evaluation on problem solving skill

Unit IV (8hours)	Schrodinger's equation for central potentials – The radial equation – Particle in an infinite spherical well – Isotropic harmonic oscillator – The Coulomb potential and the hydrogen atom problem.	• Lecture • Problem-Solving	• To extend their understanding of central potentials with applications..	• Q & A • Evaluation on problem solving skill
Unit V (9hours)	Symmetry and conservation laws –Space-time symmetries – Displacement in space and conservation of linear momentum –Displacement in time and conservation of energy – Rotation in space and conservation of angular momentum – Space inversion and conservation of parity – Time reversal symmetry. The indistinguishability principle – Symmetric and antisymmetric wavefunctions – Eigenvalues and eigenvectors of particle-exchange operator – Spin and statistics – Pauli's exclusion principle and antisymmetric wave function – The ground state of the Helium atom.	• Lecture • Problem-Solving	• To acquire knowledge on symmetry and conservation laws. • To acquire knowledge about identical particles,symmetric and antisymmetric wave functions.	• Q & A • Evaluating through internal exams

Faculty In-charge
Ms.Ancy Maria Varghese

PHY2C06:MATHEMATICAL PHYSICS -II

Semester:2
Course Number: 2
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: This course is intended to give mathematical tools necessary for better understanding of the later courses in physics such as classical mechanics, electrodynamics, quantum mechanics,solid state Physics and statistical physics.

Prerequisites: Background of the basic mathematics at +2 and degree level

Course Outline:

1. Functions of Complex Variables:
Introduction, Analyticity, Cauchy-Reimann conditions, Cauchy's integral theorem and integral formula, Laurent expansion, Singularities, Calculus of residues and applications (15 hours)-
Text:Sections 6.1 to 6.5, 7.1, 7.2

2. Group Theory:
Groups, multiplication table, conjugate elements and classes, subgroups, direct product groups, isomorphism and homomorphism, permutation groups, distinct groups of given order, reducible and irreducible representations
Text :Sections 1-1.8, Joshi.
Generators of continuous groups, rotation groups SO(2) and SO(3), rotation of functions and angular momentum, SU(2)-SO(3) homomorphism, SU(2) isospin and SU(3) eightfold way (20 hours)
Text : Sections 4.2, Arfken 5th edition.

3. Calculus of Variations:
One dependent and one independent variable, Applications of the Euler equation, Generalization to several independent variables, Several dependent and independent variables, Lagrange Multipliers, Variation subject to constraints, Rayleigh-Ritz variational technique. (14 hours)
Sections 17.1 to 17.8

4. Integral equations:
Integral equations- introduction, Integral transforms and generating functions, Neumann series, separable kernel (12 hours)-
Sections 16.1 to 16.3

5. Green's function:

Green's function, eigenfunction expansion, 1-dimensional Green's function, Green's function integral-differential equation, eigenfunction, eigenvalue equation Green's function and Dirac delta function, Enough exercises.(11 hours)

Section 9.51

Text books :

1. G.B.Arfken and H.J.Weber : “Mathematical Methods for Physicists (5th Edition, 2001)” (Academic Press)
2. A.W.Joshi, Elements of Group theory for Physicists()(New Age International (P).Ltd)

Reference books :

1. J.Mathews and R.Walker : “Mathematical Methods for Physics” (Benjamin)
2. L.I.Pipes and L.R.Harvill : “Applied Mathematics for Engineers and Physicists (3rd Edition)" (McGraw Hill)
3. Erwin Kreyzig : "Advanced Engineering Mathematics - 8th edition" (Wiley)
4. M. Greenberg : "Advanced Engineering Mathematics – 2nd edition " (Pearson India 2002)
5. Mathematical methods in the physical sciences, 2nd edn, Mary L Boas, John Wiley & Sons
6. Elementary Differential Equations and boundary value problems, William E. Boyce, Richard C. DiPrima, John Wiley & Sons, Inc.
7. Mathematics of Classical and Quantum Physics, F. W. Byron and R. W. Fuller, Dover Publications, Inc., New York

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (15hours)	Introduction, Analyticity, Cauchy-Reimann conditions, Cauchy's integral theorem and integral formula, Laurent expansion, Singularities, Calculus of residues and applications .	● Lecture ●Problem-Solving	● To know the method of contour integration to evaluate definite integrals of varying complexity.	Evaluation of problems ● Q and A
Unit II (20hours)	Groups, multiplication table, conjugate elements and classes, subgroups, direct product groups, isomorphism and homomorphism, permutation groups, distinct groups of given order, reducible and irreducible representations Generators of continuous groups, rotation groups SO(2) and SO(3), rotation of functions and angular momentum, SU(2)-SO(3) homomorphism, SU(2) isospin and SU(3) eightfold way	● Lecture ●Problem-Solving	● To gain the ability to apply group theory to physics problems. ● To know about different groups which are a prerequisite for deeper understanding of crystallography,particle physics,quantum mechanics and energy bands in solids.	● problem solving ● Q and A

Unit III(14 hours)	One dependent and one independent variable, Applications of the Euler equation, Generalization to several independent variables, Several dependent and independent variables, Lagrange Multipliers, Variation subject to constraints, Rayleigh-Ritz variational technique.	●Lecture ●Problem-Solving ●Seminar	● To be able to apply calculus of variation to diverse problems in physics. ● The use of Lagrange Multipliers in solving physics problems.	● Q & A ● Evaluation on problem solving skill
Unit IV (12 hours)	Integral equations-introduction, Integral transforms and generating functions, Neumann series, separable kernel.	● Lecture ●Problem-Solving	● To find solutions to integral equations using different methods.	● Q & A ● Evaluation on problem solving skill
Unit V (11hours)	Green's function, eigenfunction expansion, 1-dimensional Green's function, Green's function integral-differential equation, eigenfunction, eigenvalue equation Green's function and Dirac delta function, Enough exercises.	●Lecture ●Problem-Solving ● Seminar	● To become familiar with methods of Green's Function to solve linear differential equations with inhomogeneous terms..	● Q & A ● Evaluating through internal exams

Faculty in charge
Ms Sukanya I S

PHY2C07:STATISTICAL MECHANICS

Semester:2
Course Number: 3
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To under**rs**tand the properties of macroscopic systems using the knowledge of properties of microscopic particles.

Prerequisites: Background of thermodynamics at +2 and degree level

Course Outline:

1. The Statistical Basis of Thermodynamics:
The macroscopic and the microscopic states – Contact between statistics and Thermodynamics: Expressing T, P and μ in terms of Ω – The classical Ideal gas - The entropy of mixing and the Gibbs paradox - Phase space of a classical system - Liouville‵‵s theorem and its consequences. (13 Hours)
Text : Pathria, Sections 1.1 – 1.6, 2.1 – 2.2

2. Microcanonical, Canonical and Grand Canonical Ensembles:
The microcanonical ensemble – Examples : (1) Classical Ideal gas, (2) Linear harmonic oscillator - Quantum states and the phase space – Equilibrium between a system and a heat reservoir- Physical significance of the various statistical quantities in the canonical ensemble- Alternative expressions for the partition function- Examples: (1) The classical systems: Ideal gas, (2) A system of harmonic oscillators, (3) The statistics of paramagnetism - Energy fluctuations in the canonical ensemble -Equipartition theorem - Virial theorem - Equilibrium between a system and a particle-energy reservoir- Physical significance of the various statistical quantities in the grand canonical ensemble-Example : Classical Ideal gas - Density and energy fluctuations in the grand canonical ensemble. (21 Hours)
Text : Pathria, Sections 2.3 -2.5, 3.1, 3.3 - 3.9, 4.1, 4.3 – 4.5

3. Formulation of Quantum Statistics:
Quantum-mechanical ensemble theory: The density matrix- Statistics of the various ensembles-Example: An electron in a magnetic field - Systems composed of indistinguishable particles- An ideal gas in a quantum-mechanical microcanonical ensemble- An ideal gas in other quantum-mechanical ensembles-Statistics of the occupation numbers (15 Hours)
Text : Pathria, Sections 5.1 - 5.4, 6.1 – 6.3

4. Ideal Bose Systems:

Thermodynamic behaviour of an ideal Bose gas- Thermodynamics of the blackbody radiation- The field of sound waves. (10 Hours)

Text : Pathria, Sections : 7.1 - 7.3

5. Ideal Fermi Systems:

Thermodynamic behaviour of an ideal Fermi gas- Magnetic behaviour of an ideal Fermi Gas : (1) Pauli paramagnetism, (2) Landau diamagnetism – The electron gas in metals (Discussion of heat capacity only), Enoughexercises. (13 Hours)

Text : Pathria, Sections : 8.1 – 8.3

Textbook:

1. Statistical Mechanics (2nd Edition), R. K. Pathria , Butterworth-Heinemann /Elsevier (1996)

Reference books:

1. Statistical Mechanics : An Elementary Outline, Avijit Lahiri, Universities Press (2008)
2. An Introductory Course of Statistical Mechanics, Palash. B. Pal, Narosa (2008)
3. Statistical Mechanics : An Introduction, Evelyn Guha, Narosa (2008)
4. Statistical and Thermal Physics : An Introduction, S. Lokanathan and R.S.Gambhir, Prentice Hall of India (2000).
5. Introductory Statistical Mechanics (2nd Edition), Roger Bowley and Mariana Sanchez, Oxford University Press (2007)
6. Concepts in Thermal Physics, Stephen. J. Blundell and Katherine. M. Blundell, Oxford University Press (2008)
7. An Introduction to Thermal Physics, Daniel. V. Schroeder, Pearson (2006)
8. Statistical Mechanics, Donald. A. McQuarrie, Viva Books (2005)
9. Problems and Solutions on Thermodynamics and Statistical Mechanics, Ed. by Yung – Kuo Lim, Sarat Book House (2001)

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (13hours)	The macroscopic and the microscopic states – Contact between statistics and Thermodynamics: Expressing T, P and μ in terms of Ω – The classical Ideal gas - The entropy of mixing and the Gibbs paradox - Phase space of a classical system - Liouville"s theorem and its consequences. .	● Lecture ●Problem-Solving	● To explain statistical physics and thermodynamics as logical consequences of postulates of statistical mechanics. ● Applications of classical statistical mechanics.	Evaluation of problems ● Q and A
Unit II (21hours)	The microcanonical ensemble – Examples : (1) Classical Ideal gas, (2) Linear harmonic oscillator - Quantum states and the phase space – Equilibrium between a system and a heat reservoir- Physical significance of the various statistical quantities in the canonical ensemble- Alternative expressions for the partition function- Examples: (1) The classical systems: Ideal gas, (2) A system of harmonic oscillators, (3) The statistics of paramagnetism - Energy fluctuations in the canonical ensemble -Equipartition theorem - Virial theorem - Equilibrium between a system and a	● Lecture ●Problem-Solving	● To gain ideas about ensembles. ● To know about the physical significance of statistical quantities in various ensembles.	● problem solving ● Q and A

	particle-energy reservoir-Physical significance of the various statistical quantities in the grand canonical ensemble- Example : Classical Ideal gas - Density and energy fluctuations in the grand canonical ensemble.			

Unit III(15hours)	Quantum-mechanical ensemble theory: The density matrix- Statistics of the various ensembles-Example: An electron in a magnetic field - Systems composed of indistinguishable particles- An ideal gas in a quantum-mechanical microcanonical ensemble- An ideal gas in other quantum-mechanical ensembles-Statistics of the occupation numbers	●Lecture ●Problem-Solving ●Seminar	● To learn the fundamental difference between classical and quantum statistics and to learn about quantum statistical distribution law. ● .Applications of Quantum statistical mechanics	● Q & A ● Evaluation on problem solving skill
Unit IV (10 hours)	Thermodynamic behaviour of an ideal Bose gas- Thermodynamics of the blackbody radiation- The field of sound waves.	● Lecture ●Problem-Solving	● To study the important examples of the ideal bose system.	● Q & A ● Evaluation on problem solving skill

Unit V (13hours)	Thermodynamic behaviour of an ideal Fermi gas- Magnetic behaviour of an ideal Fermi Gas : (1) Pauli paramagnetism, (2) Landau diamagnetism – The electron gas in metals (Discussion of heat capacity only), Enough exercises.	●Lecture ●Problem-Solving	● To study the important examples of ideal fermi system	● Q & A ● Evaluating through internal exams

Faculty in charge
Ms Shyama I

PHY2C08:COMPUTATIONAL PHYSICS

Semester:2
Course Number: 4
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To study scientific problems using computational methods which combine computer science,physics and applied Mathematics to develop scientific solutions to complex problems.
Prerequisites: Background of the python programming language at degree level.

Course Outline:
1. Introduction to Python Programming: Concept of high level language, steps involved in the development of a Program- Compilers and Interpreters - Introduction to Python language: Inputs and Outputs, Variables, operators, expressions and statements - ,Strings, Lists, Tuples, and Dictionaries, Conditionals, Iteration and looping, Functions and Modules -.Mathematical functions (math module), File input and Output, Pickling. Formatted Printing. (13 hours)

2. Tools for maths and visualisation in Python (The numpy and pylab modules)*
Numpy module:- Arrays and Matrices – creation of arrays and matrices (arange, linspace, zeros, ones, random, reshape,copying), Arithmetic Operations, cross product, dot product , Saving and Restoring, Matrix inversion, solution of simultaneous equations, Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, .Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions, Special functions – Bessel & Gamma, Fourier Series.(13 hours)

3. Numerical Methods 1*: Interpolation: linear and polynomial interpolation, equidistant points - Newton's forward/backward difference, spline interpolation. Curve fitting- Least square fit- linear and exponential. Derivatives: Lagrange polynomials, Newton difference polynomials, finite difference approximations. Numerical integration: simple quadratures (trapezoid, Simpson). Solution of nonlinear equations: closed domain methods (bisection and regula falsi.Monte Carlo Method – Simple Integration. (15 hours)

4. Numerical Methods-2* : Ordinary differential equations: Initial value problems: the first-order Euler method, the second-order single point methods (predictor), Runge-Kutta methods. Boundary value problems: the shooting method, the equilibrium method, the Numerov's method, the eigenvalue problems - the equilibrium method . Fourier transforms: discrete Fourier transforms, fast Fourier transforms. (15 hours)

5. Computational methods in Physics and Computer simulations 12 hrs (24 marks)*:
Classical Mechanics: One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium, Two dimensional motion:Projectile motion (by Euler method) and Planetary motion (R-K Method), Accuracy considerations, -, Oscillatory motion –Ideal Simple Harmonic Oscillator (Euler method), Motion of a damped oscillator (Feynmann-Newton method)., Logistic maps. Monte-Carlo simulations: value of π, simulation of radioactivity. Quantum Mechanics: 1D Schrodinger equation –wave function and eigen values. (16 hours)
(Visualisation can be done with matplotlib/pylab)
*(Programs are to be discussed in Python)
Textbooks for Numerical Methods:
1. Introductory methods of numerical analysis, S.S. Sastry , (Prentice Hall of India,1983)
2. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other book)
3. Numerical Mathematical Analysis, J.B. Scarborough

References:
(For Python any book can be used as reference. Moreover a number of open articles are available freely in internet. Python is included in default in all GNU/Linux platforms and It is freely downloadable for Windows platform as well. However use of GNU/Linux may be encouraged).
1. www.python.org
2. Python Essential Reference, David M. Beazley, Pearson Education
3. Core Python Programming, Wesley J Chun, Pearson Education
4. Python Tutorial Release 2.6.1 by Guido van Rossum, Fred L. Drake, Jr., editor. This Tutorial can be obtained from website
http://www.altaway.com/resources/python/tutorial.pdf
5. How to Think Like a Computer Scientist: Learning with Python, Allen Downey , Jeffrey

Elkner , Chris Meyers, http://www.greenteapress.com/thinkpython/thinkpython.pdf
6. Numerical Recipes in C, second Edition(1992), Cambridge University Press
7. Numerical Recipes in Fortran 77, second Edition(1992), Cambridge University Press
8. Numpy reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (and other free resources available on net)
9. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)
10. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
11. Numerical Methods , T Veerarajan, T Ramachandran, Tata MCGraw-Hill
12. Numerical Methods with Programs I BASIC, Fortran & Pascal, S Balachandra Rao, C K Shantha. Universities Press
13. Numerical methods for scientists and engineers, K. Sankara Rao, PHI
14. Computational Physics, V.K.Mittal, R.C.Verma & S.C.Gupta-Published by Ane Books,4821,Pawana Bhawan,first floor,24 Ansari Road,Darya Ganj,New Delhi-110 002 (For theory part and algorithms. Programs must be discussed in Python)
15. Numerical Methods in Engineering with Python by Jaan Kiusalaas

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (13hours)	Concept of high level language, steps involved in the development of a Program - Compilers and Interpreters - Introduction to Python language: Inputs and Outputs, Variables, operators, expressions and statements - ,Strings, Lists, Tuples, and Dictionaries, Conditionals, Iteration and looping, Functions and Modules -. Mathematical functions (math module), File input and Output, Pickling. Formatted Printing. .	● Lecture ●Problem-Solving	Have a strong base in the python programming language regarding different data types such as list,dictionaries etc.. ● Understand python libraries and modules.	Evaluation of problems ● Q and A
Unit II (13hours)	Numpy module:- Arrays and Matrices – creation of arrays and matrices (arange, linspace, zeros, ones, random, reshape, copying), Arithmetic Operations, cross product, dot product , Saving and Restoring, Matrix inversion, solution of simultaneous equations, Data visualization- The Matplotlib, Module- Plotting graphs, Multiple plots, .Polar plots, Pie Charts, Plotting mathematical functions, Sine and other functions, Special functions–Bessel & Gamma, Fourier Series.	● Lecture ●Problem-Solving	● To get an idea about different modules such as numpy,matplotlib etc. ● Understand arrays and matrices and enable data visualisation.	● problem solving ● Q and A

Unit III (15hours)	Interpolation: linear and polynomial interpolation, equidistant points - Newton's forward/backward difference, spline interpolation. Curve fitting- Least square fit- linear and exponential. Derivatives: Lagrange polynomials, Newton difference polynomials, finite difference approximations. Numerical integration: simple quadratures (trapezoid, Simpson). Solution of non-linear equations: closed domain methods (bisection and regula falsi. Monte Carlo Method – Simple Integration.	●Lecture ●Problem-Solving ●Seminar	● To get a wide knowledge of numerical methods in computational physics that can be used to solve many problems which does not have an analytic solution.	● Q & A ● Evaluation on problem solving skill
Unit IV (15hours)	Ordinary differential equations: Initial value problems: the first-order Euler method, the second-order single point methods (predictor), Runge-Kutta methods. Boundary value problems: the shooting method, the equilibrium method, the Numerov's method, the eigenvalue problems - the equilibrium method . Fourier transforms: discrete Fourier transforms, fast Fourier transforms.	● Lecture ●Problem-Solving	● To find solutions to ordinary differential equations using Euler,R K methods etc in python language.	● Q & A ● Evaluation on problem solving skill

Unit V (16hours)	Classical Mechanics: One Dimensional Motion: Falling Objects: Introduction – Formulation: from Analytical methods to Numerical Methods - Euler Method, Freely falling body, Fall of a body in viscous medium, Two dimensional motion: Projectile motion (by Euler method) and Planetary motion (R-K Method), Accuracy considerations, -, Oscillatory motion – Ideal Simple Harmonic Oscillator (Euler method), Motion of a damped oscillator (Feynmann-Newton method)., Logistic maps. Monte-Carlo simulations: value of π, simulation of radioactivity. Quantum Mechanics: 1D Schrodinger equation – wave function and eigen values.	● Lecture ● Problem-Solving ● Seminar	● To solve physics problems using python language.	● Q & A ● Evaluating through internal exams

Faculty in charge
Ms Shyama I

Practical for Semester I & II
a) PHY1L01 & PHY2L03 (GENERAL PHYSICS)

Contact Hours per Week: 8L
Number of Credits:3
Course Evaluation: Internal & External: 1:4

Objectives of the Course:
- Learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- Adopt the skills related to research, education, and industry- academia

Prerequisites: Background of the practical knowledge at degree level.

Course Outline:
1. All the experiments should involve error analysis. Internal evaluation to be done in the respective semesters and
grades to be intimated to the controller at the end of each semester itself. Practical observation book to be
submitted to the examiners at the time of examination.
2. Eight experiments are to be done by a student in a semester. One mark is to be deducted from internal marks for
each experiment not done by the student if the required total of experiments are not done in the semesters.
3. The PHOENIX/EXPEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may
be used for the experiments wherever possible.

(At least 16 experiments should be done, 8 each for I & II semesters)

1. Y and σ - Interference method (a) elliptical (b) hyperbolic fringes. To determine Y and σ of the material of the given specimen by observing the elliptical and hyperbolic fringes formed in an interference set up
2. Y & σ by Koenig's method
3. Variation of surface tension with temperature-Jaeger's method. To determine the surface tension of water at different temperatures by Jaeger's method of observing the air bubble diameter at the instant of bursting inside water
4. Stefan's constant-To determine Stefan's constant
5. Thermal conductivity of liquid and air by Lee's disc method.

6. Dielectric constant by Lecher wire- To determine the wavelength of the waves from the given RF oscillator and the dielectric constant of the given oil by measurement of a suitable capacitance by Lecher wire setup.
7. Viscosity of a liquid - Oscillating disc method. To determine the viscosity of the given liquid by measurements on the time period of oscillation of the disc in air and in the liquid
8. Mode constants of a vibrating strip. To determine the first and second mode constants of a steel vibrating strip; Y to be measured by the Cantilever method and frequency of vibration by the Melde's string method
9. Constants of a thermocouple and temperature of inversion.
10. Study of magnetic hysteresis - B-H Curve using standard toroid / specimen in any form.
11. Maxwell's L/C bridge -To determine the resistance and inductance of the given unknown inductor by Maxwell's L/C bridge OR Anderson’s Bridge – L/C and self inductance. .(The kit developed by Indian Academy of Science can also be used)
12. Susceptibility measurement by Quincke's and Guoy's methods - Paramagnetic susceptibility of salt and specimen
13. Michelson's interferometer - (a) λ and (b) d λ and thickness of mica sheet.
14. Photoelectric effect. Determination of Plank’s constant
15. Frank Hertz experiment .To measure the ionization potential of Mercury by drawing current versus applied voltage.
16. Fabry Perot etalon -Determination of thickness of air film.
17. Elementary experiments using Laser: (a) Study of Gaussian nature of laser beam (b) Evaluation of beam spot size (c) Measurement of divergence (d) Diameter of a thin wire
18. Diffraction Experiments using lasers (a)Diffraction by single slit/double slit/circular aperture (b)Diffraction by reflection grating
19. Measurement of the thermal and electrical conductivity of Cu to determine the Lorents number.(The kit developed by Indian Academy of Science can also be used)
20. Passive filters .(The kit developed by Indian Academy of Science can also be used)
21. Microwave experiments - Determination of wavelength, VSWR, attenuation, dielectric constant.
22. Experiments with Lock-in Amplifier(a) Calibration of Lock In Amplifier (b) Phase sensitive detection (c) Mutual inductance determination (d) Low resistance determination.(The kit developed by Indian Academy of Science can also be used)
23. Cauchy’s constants using liquid prism
24. Forbes method of determining thermal conductivity
25. Zeeman effect using Fabry-Perot etalon.

Reference Books:
1. B.L. Worsnop and H.T. Flint - Advanced Practical Physics for students - Methuen & Co (1950)
2. E.V. Smith - Manual of experiments in applied Physics - Butterworth (1970)
3. R.A. Dunlap - Experimental Physics - Modern methods - Oxford University Press (1988)
4. D. Malacara (ed) - Methods of experimental Physics - series of volumes - Academic Press Inc (1988)
5. S.P. Singh –Advanced Practical Physics – Vol I & II – Pragati Prakasan, Meerut (2003) – 13th Edition

6. A.C. Melissinos and J.Napolitano, Experiments in Modern Physics, Academic Press, 2003
7. K.Muraleedhara Varier, A Practical Approach to Nuclear Physics, Narosa Publishing House (2018)

Course Plan

Sl No.	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
1 2 3 4	Y and σ - Interference method (a) elliptical (b) hyperbolic fringes. To determine Y and σ of the material of the given specimen by observing the elliptical and hyperbolic fringes formed in an interference set up Susceptibility measurement by Quincke's and Guoy's methods - Paramagnetic susceptibility of salt and specimen. Dielectric constant by Lecher wire- To determine the wavelength of the waves from the given RF oscillator and the dielectric constant of the given oil by measurement of a suitable capacitance by Lecher wire setup. Frank Hertz experiment .To measure the ionization potential of Mercury by drawing current versus applied voltage.	• Seminar • Practicals • pear learning.	• These practical papers make the student familiar with General physics experiments like Cornu's method, Quincke's method, Photoelectric effect etc	• Model Exam • Record Verification • Daily Test

5	Photoelectric effect. Determination of Plank's constant			
6	Maxwell's L/C bridge -To determine the resistance and inductance of the given unknown inductor by Maxwell's L/C bridge OR Anderson's Bridge – L/C and self inductance. .(The kit developed by Indian Academy of Science can also be used)			
7	Cauchy's constants using liquid prism			
8	Diffraction Experiments using lasers (a)Diffraction by single slit/double slit/circular aperture (b)Diffraction by reflection grating			
9	Y & σ by Koenig's method			
10	Thermal conductivity of liquid and air by Lee's disc method.			
11	Mode constants of a vibrating strip. To determine the first and second mode constants of a steel vibrating strip; Y to be measured by the Cantilever method and frequency of vibration by the Melde's string.			

12	Fabry Perot etalon -Determination of thickness of air film			
13	Passive filters .(The kit developed by Indian Academy of Science can also be used)			
14	Viscosity of a liquid - Oscillating disc method. To determine the viscosity of the given liquid by measurements on the time period of oscillation of the disc in air and in the liquid.			
15	Variation of surface tension with temperature-Jaeger's method. To determine the surface tension of water at different temperatures by Jaeger's method of observing the air bubble diameter at the instant of bursting inside water			
16	Study of magnetic hysteresis - B-H Curve using standard toroid / specimen in any form.			

Faculty in charge
Shyama I

b) PHY1L02 & PHY2L04 (ELECTRONICS)

(At least 16 experiments should be done, 8 each for I & II semesters.)
External Practical Exam for PHY1L02&PHY2L04 together will be conducted at the end of 2nd semester.

1. Study the V-I characteristics of a Silicon Controlled Rectifier – Construct half-wave and full-wave circuits using SCR.
2. a). Study the V-I characteristics of UJT. Determine intrinsic stand-off ratio. Design and construct a relaxation oscillator and sharp pulse generator for different frequencies.
b). Design and construct a time delay circuit to switch ON a suitable load driven by a SCR. Trigger the SCR using UJT.
3. a).Study the V-I characteristics of a JFET. Determine pinch-off voltage, saturation drain current and cut-off voltage of the device.
b). Design and construct a low frequency common source amplifier using JFET. Study the frequency response and measure the i/p and o/p impedances.
4. Design and construct a d.c voltage regulator using transistors and Zener diodes. Study the line and load regulation characteristics for suitable o/p voltage and maximum load current.
5. Design a single stage bipolar transistor amplifier. Compare the characteristics and performance of the circuit without feedback and with suitable negative feedback. Compare theoretical and observed magnitudes of voltage gain, i/p and o/p impedances in both cases.
6. Design and construct a differential amplifier using transistors. Study frequency response and measure i/p, o/p impedances. Also measure CMRR of the circuit.
7. a).Design and construct an amplitude modulator circuit. Study the response for suitable modulation depths.
b).Design and construct a diode A.M detector circuit to recover the modulating signal from the A.M wave.
8. Design and construct a two stage I.F amplifier circuit. Study the response of single and coupled stages.
9. Design and construct a Darlington pair amplifier using medium power transistors for a suitable output current. Study the frequency response of the circuit and measure the i/p and o/p impedances.
10. Design and construct a piezo-electric crystal oscillator to generate square waves of suitable frequencies. Compare designed and observed frequencies.
11. Design and construct an R.F oscillator using a tunnel diode. Measure frequency of the output signal.
12. Design and construct an OPAMP based summing and averaging amplifier for three suitable inputs. Compare the designed and observed outputs.
13. Design and construct a Wien bridge oscillator using OP AMP for different frequencies. Compare designed and observed frequencies.
14. Design and construct an astable multivibrator using OPAMP for suitable frequencies.
15. Design and construct a monostable multivibrator using OPAMP for suitable pulse widths.

16.Design and construct a triangular wave generator using OPAMPs for different frequencies.
17. Design and construct OPAMP based precision half and full wave rectifiers. Observe the o/p on CRO and study the circuit operation.
18.Design and construct an astable multivibrator using timer IC 555. Measure frequency and duty cycle of the o/p signal.
Modify the circuit to obtain almost perfect square waves.
19.Design and construct an monostable multivibrator using timer IC 555, for different pulse widths. Compare designed and observed pulse widths.
20.Design and construct a voltage controlled oscillator using timer IC 555. Study the performance.
21.Design and construct Schmidt triggers using OP AMPS – for symmetrical and non-symmetrical LTP/UTP. Trace hysteresis curve.
22.Design and construct OPAMP based analogue integrator and differentiator. Study the response in each case.
23. a). Design and construct OP AMP based circuit for solving a second order differential equation. Study the performance.
b). Design and construct OP AMP based circuit for solving a simultaneous equation. Study the performance.
24. Design and construct Second order Butterworth Low pass, High Pass and Band Pass filters using OPAMPs. Study the performance in each case.
25. Design and construct a narrow band-pass filter for a given centre frequency using a single OP AMP with multiple feedback. Study the frequency response.
26. 4 bit D/A converter using R-2R ladder network. Realization of 4 bit A/D converter using D/A converter.
27. Study of 4 bit binary counter (IC 7493) and 4 bit decade counter(IC 7490) in various modes. Use the counters as frequency dividers.
28. Design and construct a 3 bit binary to decimal decoder using suitable logic gates. Verify the operation.
29. Set up a four bit shift register IC 7495 and verify right shift and left shift operations for different data inputs.
References: Design and construction ideas may be obtained from standard electronics text books.
For further reference:
Basic Electronics and Lab Video Prof. T.S. Natarajan IIT Madras
http://nptel.iitm.ac.in/video.php?subjectId=122106025

Course Plan

Sl No.	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
1	Study of 4 bit binary counter (IC 7493) and 4 bit decade counter(IC 7490) in various modes. Use the counters as frequency dividers.	● Seminar ● Practicals ● pear learning.	● Design, development and testing of electronic circuits with OP amps, discrete electronic components and integrated circuit chips. ● Designing amplifier, oscillator, and wave shaping circuits for defined specifications. ● Designing electronic filters and understanding phase sensitive lock in detection technique	● Model Exam ● Record Verification ● Daily Test
2	Design and construct a Darlington pair amplifier using medium power transistors for a suitable output current. Study the frequency response of the circuit and measure the i/p and o/p impedances.			
3	Design and construct an OPAMP based summing and averaging amplifier for three suitable inputs. Compare the designed and observed outputs.			
4	Design and construct a Wien bridge oscillator using OP AMP for different frequencies. Compare designed and observed frequencies.			
5	Design and construct an astable multivibrator using timer IC 555. Measure frequency and duty cycle of the o/p signal.			

6	Design and construct an astable multivibrator using OPAMP for suitable frequencies.			
7	Design and construct a triangular wave generator using OPAMPs for different frequencies.			
8	Design and construct OPAMP based precision half and full wave rectifiers. Observe the o/p on CRO and study the circuit operation.			
9	Design and construct an monostable multivibrator using timer IC 555, for different pulse widths. Compare designed and observed pulse widths.			
10	.Design and construct a voltage controlled oscillator using timer IC 555. Study the performance.			
11	Design and construct Schmidt triggers using OP AMPS – for symmetrical and non-symmetrical LTP/UTP. Trace hysteresis curve.			
12	Design and construct OPAMP based analogue integrator and differentiator. Study the response in each case.			
13	Design and construct Second order Butterworth Low pass, High Pass and Band Pass filters using OPAMPs. Study the performance in each case.			

14	Design and construct a narrow band-pass filter for a given centre frequency using a single OP AMP with multiple feedback. Study the frequency response			
15	Design a single stage bipolar transistor amplifier. Compare the characteristics and performance of the circuit without feedback and with suitable negative feedback. Compare theoretical and observed magnitudes of voltage gain, i/p and o/p impedances in both cases			
16	Design and construct an astable multivibrator using OPAMP for suitable frequencies.			

Faculty in charge
Sukanya I S

PHY3C09:QUANTUM MECHANICS II

Semester: 3
Course Number: 1
Contact Hours: 4T
Number of Credits: 4
Number of Contact Hours: 72
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To equip them with the techniques of angular momentum, perturbation theory and scattering theory so that they can use these in various branches of physics as per their requirement.

Prerequisites: Background of Quantum mechanics I.

Course Outline
1.Time-Independent Perturbation Theory (20 Hrs.)
Non-degenerate perturbation theory – First-order theory and Second-order theory – Examples : (1) Linear harmonic oscillator (2) Anharmonic oscillator – Degenerate perturbation theory – Two-fold degeneracy – Higher-order degeneracy –The fine-structure of hydrogen – Relativistic correction – Spin-orbit coupling - Zeeman effect – Weak-field Zeeman effect– Strong-field Zeeman effect – Intermediate-field Zeeman effect – Hyperfine splitting – Linear Stark effect in the hydrogen atom.
Text : (1) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths,
(2) Chapter 8, section 8.3, Quantum Mechanics (Edn.4) by V. K. Thankappan

2.Variational Method and WKB Method (12 Hrs.)
Bound states (Ritz method) – Linear harmonic oscillator – Helium atom – WKB wavefunction in classical region – Example : Potential well with two vertical walls – WKB wavefunction in nonclassical region – Example : Tunneling – Connection formulae – Examples : (1) Potential well with one vertical wall (2) Potential well with no vertical walls.
Text : (1) Chapter 8, section 8.2A, Quantum Mechanics (Edn.4) by V. K. Thankappan
(2) Chapter 6, Introduction to Quantum Mechanics (Edn.2) by David. J. Griffiths

3.Time-dependent perturbation theory (12 Hrs.)
First order time-dependent perturbation theory – Constant perturbation – Transition to a continuum – Fermi's Golden rule – Scattering cross section in the Born approximation – Harmonic perturbation – Radiative transitions in atoms.
Text : Chapter 8, sections 8.4, 8.4A, 8.4B, Quantum Mechanics (Edn.4) by V. K. Thankappan

4. Scattering (12 Hrs.)
Scattering amplitude – Method of partial waves – Scattering by a central potential – Optical theorem – Scattering by a square-well potential
Text: Chapter 7, relevant sections, Quantum Mechanics (Edn.4) by V. K. Thankappan

5.Relativistic Quantum Mechanics (16 Hrs.)
Klein-Gordon equation – First order wave equations – Weyl equation – Dirac equation – Properties of Dirac matrices – Dirac particle is spin-1/2 particle – Spinor – Equation of continuity – Dirac particle in an external magnetic field : Non- relativistic limit – Hole theory
Text: Chapter 10, relevant sections; Quantum Mechanics (Edn.4) by V. K. Thankappan

Textbooks:
1. Quantum Mechanics (Edn.4) : V. K. Thankappan, New Age International.
2. Introduction to Quantum Mechanics (Edn.2) : D.J. Griffiths, Pearson Education.

References :
1. Principles of Quantum Mechanics (Edn.2) : R. Shankar, Springer.
2. Introductory Quantum Mechanics: Richard L. Liboff, Pearson Education .
3. A Modern Approach to Quantum Mechanics: J S Townsend, Viva Books.
4. Quantum Mechanics : Non-Relativistic Theory (Course of Theoretical Physics Vol3): L. D. Landau and E. M.
Lifshitz, Pergamon Press.
5. The Feynman Lectures on Physics Vol 3, Narosa.
6. Quantum Mechanics : Concepts and Applications (Edn.2) : NouredineZettili, Wiley.
7. Quantum Mechanics Demystified: David McMahon, McGrawHill 2006.
8. Quantum Mechanics (Schaum's Outline) :YoavPelegetal. Tata McGraw Hill Private Limited, 2/e.
9. Quantum Mechanics: 500 Problems with Solutions: G Aruldhas, Prentice Hall of India.
10. www.nptel/videos.in/2012/11/quantum-physics.html
11. https://nptel.ac.in/courses/115106066/

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (20 hours)	Non-degenerate perturbation theory – First-order theory and Second-order theory – Examples : (1) Linear harmonic oscillator (2) Anharmonic oscillator – Degenerate perturbation theory – Two-fold degeneracy – Higher-order degeneracy – The fine-structure of hydrogen – Relativistic correction – Spin-orbit coupling - Zeeman effect – Weak-field Zeeman effect – Strong-field Zeeman effect – Intermediate-field Zeeman effect – Hyperfine splitting – Linear Stark effect in the hydrogen atom.	● Lecture ●Problem-Solving	● To understand the idea of time independent perturbation theory . ● To be familiar with Hydrogen atom by its properties	Evaluation of problems ● Q and A

Unit II (12hours)	Bound states (Ritz method) – Linear harmonic oscillator – Helium atom – WKB wavefunction in classical region – Example : Potential well with two vertical walls – WKB wavefunction in nonclassical region – Example : Tunneling – Connection formulae – Examples : (1) Potential well with one vertical wall (2) Potential well with no vertical walls.	● Lecture ●Problem-Solving	● To understand Approximation methods for time-independent problems like the WKB approximation ● To acquire a deep knowledge of the connection formula and its applications.	● problem solving ● Q and A

Unit III(12 hours)	First order time-dependent perturbation theory – Constant perturbation – Transition to a continuum – Fermi's Golden rule – Scattering cross section in the Born approximation – Harmonic perturbation – Radiative transitions in atoms.	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● To get an idea time dependent Perturbation theory and Interaction of an atom with the electromagnetic field	● Q & A ● Evaluation problem solving skill
Unit IV (12hours)	Scattering amplitude – Method of partial waves – Scattering by a central potential – Optical theorem – Scattering by a square-well potential	● Lecture ●Problem-Solving ● Seminar	● To describe and understand Scattering, its parameters and its application	● Q & A ● Evaluation problem solving skill

Unit V (16hours)	Klein-Gordon equation – First order wave equations – Weyl equation – Dirac equation – Properties of Dirac matrices – Dirac particle is spin-1/2 particle – Spinor – Equation of continuity – Dirac particle in an external magnetic field : Non-relativistic limit – Hole theory	●Lecture ●Problem-Solving ● Seminar	● TO get an idea of Relativistic Quantum Mechanics using Dirac equation, Dirac matrices,. The Klein Gordon equation etc	● Q & A ● Evaluation problem solving skill

Faculty In-charge
Ms. Ancy Maria Varghese

PHY3C10 :NUCLEAR AND PARTICLE PHYSICS

Semester:3
Course Number: 2
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: The course deals with the various dimensions related to nuclear physics and structuring of atoms. It also discusses the different nuclear models.
Prerequisites: Background of Nuclear physics at degree level.

Course Outline:
1.Nuclear Forces: Properties of the nucleus, size, binding energy, angular momentum , The deuteron and two- nucleon scattering experimental data, Simple theory of the deuteron structure, Low energy n-p scattering, characteristics of nuclear forces, Spin dependence,Tensor force, Scattering cross sections, Partial waves, Phase shift, Singlet and triplet potentials, Effective range theory, p-p scattering. (12 hours)
Text: K.S.Krane : "Introductory Nuclear Physics" (Wiley), (Ch. 3 and 4)

2. Nuclear Decay: Basics of alpha decay and theory of alpha emission, Beta decay, Energetics of beta decay,Fermi theory of beta decay, Comparative half-life, Allowed and forbidden transitions, Selection rules, Parity violation in beta decay. Neutrino. Energetics of Gamma Decay, Multipole moments, Decay rate, Angular

momentum and parity selection rules, Internal conversion, Lifetimes. (12 hours)
Text: K.S.Krane : “Introductory Nuclear Physics” (Wiley), (Ch. 8, 9 and 10)

3. Nuclear Models, Fission and Fusion: Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons, Collective structure, Nuclear vibrations, Nuclear rotations,Liquid drop Model, Semi Empirical Mass formula, Energetics of Fission process, Controlled Fission reactions.Fusion process, Characteristics of fusion, solar fusion, Controlled fusion reactors. (19 hours)
Text: K.S.Krane : “Introductory Nuclear Physics” (Wiley), (Ch. 5,13.1-13.5,14)

4. Nuclear Radiation Detectors and Nuclear Electronics: Gas detectors – Ionization chamber, Proportional counter and G M counter, Scintillation detector, Photomultiplier Tube (PMT), Semiconductor detectors – Ge(Li), Si(Li) and surface barrier detectors, Preamplifiers, Amplifiers, Single channel analyzers, Multi- channel analyzers, counting statistics, energy measurements. (12 hours)
Text: S S Kapoor and V S Ramamurthy: “Nuclear Radiation Detectors” (Wiley)

5. Particle Physics: Four basic forces - Gravitational, Electromagnetic, Weak and Strong - Relative strengths, classification of particles, Yukawa's theory, Conservation of energy and masses, Electric charges, Conservation of angular momentum, Baryon and lepton numbers, Conservation of strangeness, Conservation of isospin and its components, Conservation of parity, Charge conjugation, CP violation, time reversal and CPT theorem. Extremely short lived particles, Resonances - detecting methods and experiments, Internal symmetry, The Sakata model, SU (3), The eightfold way, Gell Mann and Okubo mass formula, Quarks and quark model, Confined quarks, Experimental evidence, Coloured quarks. (17 hours)
Text : Y.Neeman and Y.Kirsh: "The particle hunters' (Cambridge University Press), Ch 6.1- 3, 3.4, 7.1-10,
8.1, 9. 1-7)

Reference Books :

1. H.S.Hans : “Nuclear Physics – Experimental and theoretical” (New Age International, 2001).
2. G.F.Knoll : “Radiation Detection and Measurement, (Fourth Edition, Wiley, 2011)
3. G.D.Coughlan, J.E.Dodd and B.M.Gripalos “The ideas of particle physics – an introduction for scientists”, (Cambridge Press)
4. David Griffiths – “Introduction to elementary particles” – Wiley (1989)
5. S.B.Patel : “An Introduction to Nuclear Physics” (New Age International Publishers)
6. Samuel S.M.Wong: “Introductory Nuclear Physics” (Prentice Hall,India)
7.B.L.Cohen : “Concepts of Nuclear Physics” (Tata McGraw Hill)
8.E.Segre : “Nuclei and Particles” (Benjamin, 1967)
9.K Muraleedhara Varier: “Nuclear Radiation Detection: Measurement and Analysis” (Narosa).

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (12hours)	Properties of the nucleus, size, binding energy, angular momentum , The deuteron and two-nucleon scattering experimental data, Simple theory of the deuteron structure, Low energy n-p scattering, characteristics of nuclear forces, Spin dependence,Tensor force, Scattering cross sections, Partial waves, Phase shift, Singlet and triplet potentials, Effective range theory, p-p scattering.	● Lecture ●Problem-Solving	● have a basic knowledge of nuclear size ,shape , binding energy.etc and also the characteristics of nuclear force in detail. ● Understand different types of scattering.	Evaluation of problems ● Q and A
Unit II (12hours)	Basics of alpha decay and theory of alpha emission, Beta decay, Energetics of beta decay, Fermi theory of beta decay, Comparative half-life, Allowed and forbidden transitions, Selection rules, Parity violation in beta decay. Neutrino. Energetics of Gamma Decay, Multipole moments, Decay rate, Angular momentum and parity selection rules, Internal conversion, Lifetimes.	● Lecture ●Problem-Solving	● To acquire knowledge about nuclear decay processes and their outcomes. ● Have a wide understanding regarding beta and gamma decay.	● problem solving ● Q and A

Unit III (19hours)	Shell model potential, Spin-orbit potential, Magnetic dipole moments, Electric quadrupole moments, Valence Nucleons, Collective structure, Nuclear vibrations, Nuclear rotations, Liquid drop Model, Semi Empirical Mass formula, Energetics of Fission process, Controlled Fission reactions. Fusion process, Characteristics of fusion, solar fusion, Controlled fusion reactors.	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● To be able to gain knowledge about various nuclear models and potentials associated.	● Q & A ● Evaluation problem solving skill
Unit IV (12hours)	Gas detectors – Ionization chamber, Proportional counter and G M counter, Scintillation detector, Photomultiplier Tube (PMT), Semiconductor detectors – Ge(Li), Si(Li) and surface barrier detectors, Preamplifiers, Amplifiers, Single channel analyzers, Multi- channel analyzers, counting statistics, energy measurements.	● Lecture ●Problem-Solving ● Seminar	● To Grasp knowledge about Nuclear reactions, Fission and Fusion and their characteristics	● Q & A ● Evaluation problem solving skill
Unit V (17hours)	Physics: Four basic forces - Gravitational, Electromagnetic, Weak and Strong - Relative strengths, classification of particles, Yukawa's theory, Conservation of energy and masses, Electric charges, Conservation of angular momentum, Baryon and lepton	●Lecture ●Problem-Solving ● Seminar	● To understand the basic forces in nature and classification of particles ● To study in detail conservation laws and quark models in detail.	● Q & A ● Evaluation problem solving skill

	numbers, Conservation of strangeness, Conservation of isospin and its components, Conservation of parity, Charge conjugation, CP violation, time reversal and CPT theorem. Extremely short lived particles, Resonances - detecting methods and experiments, Internal symmetry, The Sakata model, SU (3), The eightfold way, Gellmann and Okubo mass formula, Quarks and quark model, Confined quarks, Experimental evidence, Coloured quarks.			

Faculty In-charge
Ms. Shyama I

PHY3C11: SOLID STATE PHYSICS

Semester:3
Course Number: 3
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To understand Energy band theory, Formation of energy bands. Gaps at Brillouin zone boundaries, distinction between metal, insulator, semiconductor, weak and tight binding approximations
Prerequisites: Background of Solid state physics at degree level.

Course Outline
1. Crystal Structure and binding:Symmetry elements of a crystal, Types of space lattices, Miller indices, Diamond Structure, NaCI Structure,BCC, FCC,HCP structures with examples, Description

of X-ray diffraction using reciprocal lattice, Brillouin zones,Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals,Covalent bonding, Metallic bonding, Hydrogen-bonded crystals (12 hours)

2. Lattice Vibrations:
Vibrations of monatomic and diatomic lattices, Quantization of lattice vibrations, Inelastic scattering of neutrons, Einstein and Debye models of specific heat, Thermal conductivity, Effect of imperfection (9 hours)

3. Electron States and Semiconductors:
Free electron gas in three dimensions, Specific heat of metals, Sommerfeld theory of electrical conductivity, Wiedemann-Franz law, Hall effect, Nearly free electron model and formation of energy bands, Bloch functions, Kronig Penny model, Formation of energy gap at Brillouin zone boundaries, Number of orbitals in a band, Equation of motion of electrons in energy bands, Properties of holes, Effective mass of carriers, Intrinsic carrier concentration, Hydrogenic model of donor and acceptor states. Direct band gap and indirect band gap semiconductors (17 hours)

4. Dielectric, Ferroelectric and magnetic properties:
Theory of Dielectrics: polarization, Dielectric constant, Local Electric field, Dielectric polarisability, Polarisation from Dipole orientation, Ferroelectric crystals, Order-disorder type of ferroelectrics, Properties of Ba Ti O3, Polarisation catastrophe, Displasive type ferroelectrics, Landau theory of ferroelectric phase transitions, Ferroelectric domain, Antiferroelectricity, Piezoelectricity, Applications of Piezoelectric Crystals,Diamagnetism and Paramagnetism: Langevin's theory of diamagnetism, Langevin's theory of paramagnetism, theory of Atomic magnetic moment, Hund‟s rule, Quantum theory of magnetic Susceptibility Ferro, Anti and Ferri magnetism: Weiss theory of ferromagnetism, Ferromagnetic domains, Neel Model of Antiferromagnetism and Ferrimagnetism, Spin waves, Magnons in Ferromagnets (qualitative) (22 hours)

5. Superconductivity:
Meissner effect, Type I and Type II superconductors, energy gap Isotope effect, London equation and penetration of magnetic field, Cooper pairs and the B C S ground state (qualitative, Flux quantization, Single particle tunneling, DC and AC Josephson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises. (12 hours)

Text books:

1. C.Kittel,: Introduction to Solid State Physics 5th edition (Wiley Eastern)
2. A.J.Dekker: Solid State Physics (Macmillian 1958)

Reference Books:

1. M.Ali Omar, Elementary Solid State Physics, Addison-Wesley Publishing Company
2. N.W. Ashcroft and Mermin : Solid State Physics (Brooks Cole (1976)
3. Elements of Solid State Physics, Srivastava J.P. Prentice Hall of India (2nd edn)
4. Ziman J.H. Principles of Theory of Solids - (Cambridge 1964)

5. Harald Ibach and Hans Luth, Solid State Physics : An Introduction to Principles of Solid State Physics,
Springer (2009)

Course Plan

Unit/hours (time required)	**Topics to be taught (input)**	**Procedure (process) Student centric Method of teaching**	**Activity Learning outcome(output)**	**Assessment**
Unit I (12hours)	Symmetry elements of a crystal, Types of space lattices, Miller indices, Diamond Structure, NaCI Structure, BCC, FCC,HCP structures with examples, Description of X-ray diffraction using reciprocal lattice, Brillouin zones, Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen-bonded crystals	● Lecture ●Problem-Solving	● have a basic knowledge of crystal systems and spatial symmetries ● To be able to account for how crystalline materials are studied using diffraction, including concepts like reciprocal lattice and Brillouin zones	Evaluation of problems ● Q and A

Unit II (9hours)	Vibrations of monatomic and diatomic lattices, Quantization of lattice vibrations, Inelastic scattering of neutrons, Einstein and Debye models of specific heat, Thermal conductivity, Effect of imperfection	● Lecture ●Problem-Solving	● To know what phonons are, and be able to perform estimates of their dispersive and thermal properties , be able to calculate thermal and electrical properties in the free-electron model	● problem solving ● Q and A

Unit III(17 hours)	Free electron gas in three dimensions, Specific heat of metals, Sommerfeld theory of electrical conductivity, Wiedemann-Franz law, Hall effect, Nearly free electron model and formation of energy bands, Bloch functions, Kronig Penny model, Formation of energy gap at Brillouin zone boundaries, Number of orbitals in a band, Equation of motion of electrons in energy bands, Properties of holes, Effective mass of carriers, Intrinsic carrier concentration, Hydrogenic model of donor and acceptor states. Direct band gap and indirect band gap semiconductors	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● To know Bloch's theorem and what energy bands ● know the fundamental principles of semiconductors	● Q & A ● Evaluation problem solving skill

Unit IV (22hours)	Theory of Dielectrics: polarization, Dielectric constant, Local Electric field, Dielectric polarisability, Polarisation from Dipole orientation, Ferroelectric crystals, Order-disorder type of ferroelectrics, Properties of Ba Ti O3, Polarisation catastrophe, Displacive type ferroelectrics, Landau theory of ferroelectric phase transitions, Ferroelectric domain, Antiferroelectricity, Piezoelectricity, Applications of Piezoelectric Crystals, Diamagnetism and Paramagnetism: Langevin's theory of diamagnetism, Langevin's theory of paramagnetism, theory of Atomic magnetic moment, Hund"s rule, Quantum theory of magnetic Susceptibility Ferro, Anti and Ferri magnetism: Weiss theory of ferromagnetism, Ferromagnetic domains, Neel Model of Antiferromagnetism and Ferrimagnetism, Spin waves, Magnons in Ferromagnets	• Lecture •Problem-Solving	• To know the fundamentals of dielectric and ferroelectric properties of materials • To know basic models of dia, para and ferro magnetism	• Q & A • Evaluation problem solving skill

Unit V (12hours)	Meissner effect, Type I and Type II superconductors, energy gap Isotope effect, London equation and penetration of magnetic field, Cooper pairs and the B C S ground state (qualitative, Flux quantization, Single particle tunneling, DCand AC Josephson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises. and AC Josephson effects, High Tc Superconductors(qualitative) description of cuprates, Enough exercises.	●Lecture ●Problem-Solving ● Seminar	● To be able to explain superconductivity using BCS theory	● Q & A ● Evaluation problem solving skill

Faculty in charge
Sukanya I S

PHY3E05: EXPERIMENTAL TECHNIQUES

Semester:3
Course Number: 4
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To offer excellent preparation for a career in a research laboratory in the high-tech industry, or as a MSc student to get an idea about research techniques.

Prerequisites: Background of Nuclear physics at degree level.

Course Outline

1. Vacuum Techniques : Units and basic definitions, Roughing pumps - Oil sealed rotary vacuum pump and Sorption pump, High vacuum pumps – Turbo molecular pump, Diffusion pump, Oil vapour booster pump, Ion pumps - Sputter ion pump and Getter ion pump, Cryo pump, Vacuum gauges - Pirani gauge, Thermocouple gauge, penning gauge (Cold cathode
Ionization gauge) and Hot filament ionization gauge, Vacuum accessories – Diaphragm, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves, Traps - Liquid nitrogen trap, Sorption traps, and, gaskets and O rings (19 hours)
Text : Muraleedhara Varier et al. “Advanced Experimental Techniques in Modern Physics”, Sections 1.4, 1.6 – 1.8, 1.9.2.3 –1.9.2.5, 1.10.1, 1.10.6, 1.10.3

2. Thin film techniques : Introduction, Fabrication of thin films, Thermal evaporation in vacuum – Resistive heating, Electron beam evaporation and laser evaporation techniques, Sputter deposition, Glow discharge, Thickness measurement by quartz crystal monitor, optical interference method, electrical conductivity measurement, Thermo electric power, Interference filters - Multilayer optical filters, Technological Applications of thin films. (14 hours)
Text : Muraleedhara Varier, et al. “Advanced Experimental Techniques in Modern Physics” Sections 2.1, 2.2.1.1, 2.2.1.4, 2.2.1.5, 2.2.2, 2.3.2, 2.3.3, 2.3.1, 2.7, 2.6.1

3.Accelerator techniques : High voltage DC accelerators, Cascade generator, Van de Graaff accelerator, Tandem Van de Graaff accelerator, Linear accelerator, Cyclotron, Synchrotron (Electron and proton), Ion sources – Ionization processes,
simple ion source, ion plasma source and RF ion source, Ion implantation – techniques and profiles, Ion beam sputtering–Principles and applications. (14 hours)
Text : Muraleedhara Varier, et al. “Advanced Experimental Techniques in Modern Physics”, Sections 4.3, 4.4, 4.5.1, 4.5.4,
4.5.5, 4.6, 4.8.1 – 4.8.3, 4.9

4. Materials Analysis by nuclear techniques: Introduction, Basic principles and requirements, General experimental setup, mathematical basis and nuclear reaction kinematics, Rutherford backscattering – introduction, Theoretical background – classical and quantum mechanical, experimental setup, energy loss and straggling and applications. Neutron activation analysis – principles and experimental arrangement, applications, Proton induced X-ray Emission – principle and experimental set up, applications to water samples, human hair samples and forensic samples, limitations of PIXE.
(15 hours)
Text: Advanced Experimental Techniques in Modern Physics – K. Muraleedhara Varier, Antony Joseph and P.P.Pradyumnan, Pragati Prakashan, Meerut (2006)

5. X- Ray Diffraction Technique :Introduction, Lattice planes and Bragg's Law, Diffractometer - Instrumentation, Single crystal and Powder diffraction, Scherrer equation, Structure factor,

Applications of XRD - Crystallinity, Unit Cell Parameters, Phase transition studies, thin film studies, Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data. (10 hours)

Text: Elements of Modern X-ray Physics, Jens Als Nielsen and Des McMorrow, (John Wiley and Sons 2000)

Reference books:

1. Scientific foundations of vacuum techniques – S. Dushman and J.M. Laffer, John Wiley New York (1962)
2. Thin film phenomena – K.L. Chopra, McGraw Hill (1983)
3. R. Sreenivasan – Approach to absolute zero - Resonance magazine Vol 1 no 12, (1996) , vol 2 nos 2, 6 and 10 (1997)
4. R. Berry, P.M. Hall and M.T. Harris – Thin film technology – Van Nostrand (1968)
5. Dennis and Heppel – Vacuum system design
6. Nuclear Micro analysis – V. Valkovic
7. B.D. Cullity, Elements of X-ray diffraction, Addison Wesley Inc (1978)
8. Useful link for XRD-http://pd.chem.ucl.ac.uk/pdnn/powintro/whatdiff.htm

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (19hours)	Units and basic definitions, Roughing pumps - Oil sealed rotary vacuum pump and Sorption pump, High vacuum pumps – Turbo molecular pump, Diffusion pump, Oil vapour booster pump, Ion pumps - Sputter ion pump and Getter ion pump, Cryo pump, Vacuum guages - Pirani gauge, Thermocouple gauge, penning guage (Cold cathode Ionization guage) and Hot filament ionization gauge, Vacuum accessories – Diaphragm, Gate valve, Butterfly valve, Baffle and isolation valves, magnetic valves, adjustable valves, air inlet valves, Traps - Liquid nitrogen trap, Sorption traps, and gaskets and O rings	● Lecture ●Problem-Solving	● Have gained a clear understanding of different vacuum pumps ● the production and maintenance of vacuum systems and its uses and needs in Physics	Evaluation of problems ● Q and A

Unit II (14hours)	Introduction, Fabrication of thin films, Thermal evaporation in vacuum – Resistive heating, Electron beam evaporation and laser evaporation techniques, Sputter deposition, Glow discharge, Thickness measurement by quartz crystal monitor, optical interference method, electrical conductivity measurement, Thermo electric power, Interference filters - Multi layer optical filters, Technological Applications of thin films.	● Lecture ●Problem-Solving	● Understands in depth about thin film preparation and production controlling techniques ● the application of thin films in the field of science & Technology.	● problem solving ● Q and A

Unit III(14hours)	High voltage DC accelerators, Cascade generator, Van de Graaff accelerator, Tandem Van de Graaff accelerator, Linear accelerator, Cyclotron, Synchrotron (Electron and proton), Ion sources – Ionization processes, simple ion source, ion plasma source and RF ion source, Ion implantation – techniques and profiles, Ion beam sputtering– principles and applications.	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● Extend their understanding of various particle accelerators and its industrial uses.	● Q & A ● Evaluation problem solving skill

Unit IV (15hours)	Introduction, Basic principles and requirements, General experimental setup, mathematical basis and nuclear reaction kinematics, Rutherford backscattering – introduction, Theoretical background – classical and quantum mechanical, experimental setup, energy loss and straggling and applications. Neutron activation analysis – principles and experimental arrangement, applications, Proton induced X-ray Emission – principle and experimental setup, applications to water samples, human hair samples and forensic samples, limitations of PIXE.	● Lecture ●Problem-Solving	● To understand about mathematical basis of nuclear reactors ● To discuss PIXE and its applications.	● Q & A ● Evaluation problem solving skill
Unit V (10hours)	:Introduction, Lattice planes and Bragg's Law, Diffractometer - Instrumentation, Single crystal and Powder diffraction, Scherrer equation, Structure factor, Applications of XRD - Crystallinity, Unit Cell Parameters, Phase transition studies, thin film studies, Awareness on Powder Diffraction File (PDF) of the International Centre for Diffraction Data.	●Lecture ●Problem-Solving ● Seminar	● To understand about different material analysis techniques and applications.	● Q & A ● Evaluation problem solving skill

Faculty in charge
Sukanya I S

PHY4C12: ATOMIC AND MOLECULAR SPECTROSCOPY

Semester:4
Course Number: 1
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: To understand about Electron-Atom, Ion-Atom, Atom-Atom Scattering, Atoms in strong EM fields, Ionisation by charged particles and photons Diatomic Molecules, Molecular Orbitals, Angular Momentum Born-Oppenheimer Approximation, Potential Energy Curves, Electronic, Vibrational and Rotational degrees of freedom Optical, Infrared, Microwave and Raman Spectroscopy

Prerequisites: Background of Spectroscopy at degree level.

Course Outline

1. Atomic Spectroscopy: (12 hours)

Vector Atom model – L S coupling & J J coupling, effect of electric & magnetic field on atoms and molecules; Zeeman effect, Paschen Back effect and stark effect

Text: Sections 10.1 to 10.11, 12.1to12.10, 13.1 to13.9, 20.1to 20.8 –Introduction to atomic spectra by H E White

2. Microwave and Infrared spectroscopy: (17 hours)

The spectrum of non rigid rotator, e.g. of HF, spectrum of symmetric top molecule e.g. of CH3Cl, Instrumentation for Microwave Spectroscopy Stark Modulator, Information derived from Rotational Spectrum: I R Spectroscopy: Born – Oppenheimer approximation, Effect of Breakdown of Born Oppenheimer approximation, Normal modes and vibration of H2O and CO2. Instrumentation for I R Spectroscopy – Fourier transformation I R Spectroscopy

Text: Sections 6.6 ,6.7,6.8,6.9 6.11,6.13,6.14 7.1 to 7.71,7.12,7.15,7.16,7.17,7.18 Molecular structure and Spectroscopy
by G. Aruldhas

3. Raman Spectroscopy: (14 hours)

Rotational Raman Spectrum of Symmetric top molecules, e.g. of CHCl3 Combined use of Raman & IR Spectroscopy in structure determination e.g. of CO2 and NO3. Instrumentation for Raman Spectroscopy, Non-linear Raman effects, Hyper Raman effect, stimulated Raman effect and Inverse Raman Effect

Text: Sections 8.32, 8.4, 8.5, 8.6, 8.7, 8.10, 15.1, 15.215.3, 15.4 Molecular structure and Spectroscopy by G.Aruldhas

4. Electronic Spectroscopy of molecules: (12 hours)

Vibrational Analysis of band systems, Deslander's table, Progressions & sequences, Information Derived from vibrational analysis, Franck Condon Principle. Rotational fine structure and P R and R Branches, fortrat Diagram, Dissociation Energy, Example of Iodine molecule

Text: Sections 9.1 to9.9 Molecular structure and Spectroscopy by G .Aruldhas

5. Spin Resonance Spectroscopy: (17 hours)

Interaction of nuclear spin and magnetic field, level population Larmour precession, Resonance Conditions, Bloch equations, Relaxation times, Spin-spin and spin lattice relaxation. The chemical shift, Instrumentation for NMR spectroscopy, Electron Spin Spectroscopy of the unpaired e, Total Hamiltonian, Fine structure, Electron Nucleus coupling, and hyperfine spectrum ESR spectrometer. Mossbauer Spectroscopy, Resonance fluorescence of γ-rays, Recoilless emission of γ-rays and Mossbauer effect, Chemical shift, effect of magnetic field. Eg. of Fe57 Experimental techniques, Enough

exercises.

Text: Sections 10.1 to 10.9, 11.1 to11.5.4, 13.1 to13.5 Molecular structure and Spectroscopy by G.Aruldhas

Textbooks:

1. Molecular Structure & Spectroscopy G Aruldhas
2. C N Banwell & E.M. Mccash – Fundamentals of Molecular Spectroscopy
3. Atomic Spectroscopy – White

Reference books:

1. Straughan and Walker Spectroscopy Volume I, II and III
2. G.M.Barrow – Introduction to Molecular Spectroscopy
3. H.H. Willard, Instrumental Methods of Analysis,7th Edition , CBS-Publishers, New Delhi.
4. Atomic Spectroscopy –K P Rajappan Nair, MJP Publishers, Chennai
5. Elements of spectroscopy Gupta Kumar –Pragati Prakasan ,Meerut

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (12hours)	Vector Atom model – L S coupling & J J coupling, effect of electric & magnetic field on atoms and molecules; Zeeman effect, Paschen Back effect and stark effect	● Lecture ●Problem-Solving	● know about different atom model and will be able to differentiate different atomic systems, ● different coupling schemes and their interactions with magnetic and electric fields.	Evaluation of problems ● Q and A
Unit II (17hours)	The spectrum of non rigid rotator, e.g. of HF, spectrum of symmetric top molecule e.g. of CH_3Cl, Instrumentation for Microwave Spectroscopy Stark Modulator, Information derived from Rotational Spectrum: I R Spectroscopy: Born – Oppenheimer approximation, Effect of Breakdown of Born Oppenheimer approximation, Normal modes and vibration of H_2O and CO_2. Instrumentation for I R Spectroscopy – Fourier transformation I R Spectroscopy	● Lecture ●Problem-Solving	● Have gained ability to apply the techniques of microwave and infrared spectroscopy ● To elucidate the structure of molecules	● problem solving ● Q and A

Unit III(14hours)	Rotational Raman Spectrum of Symmetric top molecules, e.g. of CHCl3 Combined use of Raman & IR Spectroscopy in structure determination e.g. of CO2 and NO3. Instrumentation for Raman Spectroscopy, Non-linear Raman effects, Hyper Raman effect, stimulated Raman effect and Inverse Raman Effect .	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	● Be able to apply the principle of Raman spectroscopy and its applications in the different field of science & Technology.	● Q & A ● Evaluation problem solving skill
Unit IV (12hours)	Vibrational Analysis of band systems, Deslander's table, Progressions & sequences, Information Derived from vibrational analysis, Franck Condon Principle. Rotational fine structure and P R and R Branches, fortrat Diagram, Dissociation Energy, Example of Iodine molecule	● Lecture ●Problem-Solving	● To become familiar with different resonance spectroscopic techniques and its applications	● Q & A ● Evaluation problem solving skill
Unit V (17hours)	Interaction of nuclear spin and magnetic field, level population Larmour precession, Resonance Conditions, Bloch equations, Relaxation times, Spin-spin and spin lattice relaxation. The chemical shift, Instrumentation for NMR spectroscopy, Electron Spin Spectroscopy of the unpaired e, Total Hamiltonian, Fine structure, Electron Nucleus coupling, and hyperfine spectrum ESR spectrometer. Mossbauer Spectroscopy,	●Lecture ●Problem-Solving ● Seminar	● to find solutions to problems related to different spectroscopic systems.	● Q & A ● Evaluation problem solving skill

	Resonance fluorescence of γ-rays, Recoilless emission of γ-rays and Mossbauer effect, Chemical shift, effect of magnetic field. Eg. of Fe57 Experimental techniques, Enough exercises.			

Faculty in charge
Sukanya I S

PHY4E14:COMMUNICATION ELECTRONICS

Semester:4
Course Number: 2
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course:

Prerequisites: Background of Nuclear physics at degree level.

Course Outline
1. Amplitude and angle modulation:
Amplitude modulation – Amplitude modulation and demodulation circuits – single side band generation and detection – SSB balanced modulator – Comparison of signal to noise ratios – Frequency modulation - Phase modulation – Angle modulation circuits – Detection of FM signals –Foster–Seeley discriminator – Ratio detector – Noise in FM (12 hours)

2. Pulse modulation and digital communication:
Elements of information theory – Pulse transmission – Pulse amplitude modulation – Pulse time modulation – Pulse code modulation – Coding – Codes – Error detection and correction codes – Digital carrier systems – Teleprinter and telegraph circuits (12 hours)
3. Communication systems:
Receivers – Superheterodyne receiver – AM receivers – Automatic gain control –Communications

receivers – FM receivers – Single and independent side band receivers. Transmitters –Telegraph transmitters – AM transmitters – FM transmitters – Television transmitters HF radio systems –VHF/UHF systems – Microwave systems – Satellite communications (15 hours)

4. Signals and Systems:

Classifications of signals, concept of frequency in continuous - time and discrete –time signals. Theory of A/D and D/A conversion, Sampling of Analog signals, sampling Theorem. Quantization of continuous amplitude signal, Coding of quantized samples, Discrete time linear time invariant systems - Techniques of analysis of linear systems, Resolution of a discrete time signal into impulses- Response of LTI systems to arbitrary inputs :Convolution sum- properties of convolution and the interconnection of LTI systems-Causal LTI
systems – Stability of LTI systems. (15 hours)

5. Radiation and antennas:

Potential functions and the EM field – Radiation from an oscillating dipole –Power radiated by a current element – Radiation resistance of a short dipole – Radiation from a quarter wave monopole - Directivity – Gain and effective aperture - Antenna arrays – Two element, linear and binomial – Frequency independent antenna – Log periodic antenna – Yagi antenna. Propagation of radio waves - Ground waves, Sky wave propagation, Space waves, Tropospheric scatter propagation, Extra terrestrial communication. Ionosphere –Reflection and refraction of waves by the ionosphere – Attenuation, Enough exercises. (18 hours)

Text and Reference books:

1. “Electronic Communications”, Roddy and Coolen, J., (PHI, 1986). Chapters 7, 8, 9, 10, 11, 12, 18, 19
2. “Electronic Communication Systems”, 4th Edition, Kennedy, G. and Davis, B. (McGraw Hill, 1992). Chapter 6,8.
3. “Electromagnetic waves and Radiating Systems”, Jordan E.C. and Balmain, K.G. (PHI, 1979). Chapters 10,11,15,17.
4. “Digital Signal Processing” by Proakis and Manolakis, Prentice Hall of India (1997)

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (12hours)	Amplitude modulation – Amplitude modulation and demodulation circuits – single side band generation and detection – SSB balanced modulator – Comparison of signal to noise ratios – Frequency modulation - Phase modulation – Angle modulation circuits – Detection of FM signals –Foster–Seeley discriminator – Ratio detector – Noise in FM	● Lecture ●Problem-Solving	● Describe different types of noise and predict its effect on various analog communication systems. ● Express the basic concepts of analog modulation schemes.	Evaluation of problems ● Q and A
Unit II (12hours)	Elements of information theory – Pulse transmission – Pulse amplitude modulation – Pulse time modulation – Pulse code modulation – Coding – Codes – Error detection and correction codes – Digital carrier systems – Teleprinter and telegraph circuits	● Lecture ●Problem-Solving	● Understand Pulse modulation and its classifications ● To know the various steps involved in pulse modulation.	● problem solving ● Q and A

Unit III(15hours)	Receivers – Superheterodyne receiver – AM receivers – Automatic gain control –Communications receivers – FM receivers – Single and independent side band receivers. Transmitters –Telegraph transmitters – AM transmitters – FM transmitters – Television transmitters HF radio systems –VHF/UHF systems – Microwave systems – Satellite communications	●Lecture ●Problem-Solving ● Seminar ● Powerpoint presentation	• Analyse different characteristics of the receiver.	• Q & A • Evaluation problem solving skill
Unit IV (15hours)	Classifications of signals, concept of frequency in continuous - time and discrete –time signals. Theory of A/D and D/A conversion, Sampling of Analog signals, sampling Theorem. Quantization of continuous amplitude signal, Coding of quantized samples, Discrete time linear time invariant systems - Techniques of analysis of linear systems, Resolution of a discrete time signal into impulses-Response of LTI systems to arbitrary inputs :Convolution sum-properties of convolution and the interconnection of LTI systems-Casual LTI systems – Stability of LTI systems.	● Lecture ●Problem-Solving	• To understand signals and its classifications. • To discuss linear time invariant systems.	• Q & A • Evaluation problem solving skill

Unit V (10hours)	Potential functions and the EM field – Radiation from an oscillating dipole –Power radiated by a current element – Radiation resistance of a short dipole – Radiation from a quarter wave monopole - Directivity – Gain and effective aperture - Antenna arrays – Two element, linear and binomial – Frequency independent antenna – Log periodic antenna – Yagi antenna. Propagation of radio waves - Ground waves, Sky wave propagation, Space waves, Tropospheric scatter propagation, Extra terrestrial communication. Ionosphere –Reflection and refraction of waves by the ionosphere – Attenuation, Enough exercises.	●Lecture ●Problem-Solving ● Seminar	● To get an idea of antenna and its properties ● To understand about propagation of radio waves	● Q & A ● Evaluation problem solving skill

Faculty in charge
Ancy maria Varghese

PHY4E20: MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS

Semester:4
Course Number:3
Contact Hours per Week: 4T
Number of Credits:4
Number of Contact Hours: 72 hrs
Course Evaluation: Internal & External: 1:4

Objectives of the Course: This course is designed to provide students with the necessary foundation for entry-level industrial applications in process monitoring and controlling, with an emphasis on analysis, problem solving, exposure to open-ended problems and design methods. At the end of the course, students will be able to design an application based on microcontrollers or microprocessors.

Prerequisites: Background of microprocessor in electronics at pg level

1.Microprocessor and Assembly language programming :
Microprocessor as CPU, Internal architecture of Intel 8085, Instruction set, Addressing modes, Examples of Assembly language programming, Addition and subtraction of 2 byte numbers, multiplication and division of 1 byte numbers, Sorting of 1 byte numbers (12 hrs)
Text: 1. Introduction to Microprocessors–A.P. Mathur (Tata-McGraw Hill).
2. Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai

2 Microprocessor timings; Interfacing memory and I/O devices :
Instruction cycles, machine cycles and timing diagram, address space partitioning, generation of control signals for memory and I/O device interfacing, memory interfacing, I/O device interfacing, Address decoding using 74LS138 (10 hrs)
Text: 1. "Introduction to Microprocessors" –A.P. Mathur (Tata-McGraw Hill).
2 Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai

3 Peripheral devices and interfacing :
Programmable Peripheral Interface- Intel 8255, Programmable Interval Timer- Intel 8253, Programmable DMA controller- Intel 8257, Programmable Interrupt controller- Intel 8259. ADC interfacing - General idea with block diagram, 7 segment LED display interfacing – General idea of display and driver (16 hrs)
Text 1. Fundamentals of Microprocessors and Microcomputers– B. Ram – Dhanapati Rai
2. Introduction to Microprocessors –A.P. Mathur (Tata-McGraw Hill).
3.Microprocessors – Architecture, Programming and Applications with 8085 - R.S.Gaonkar (Wiley Eastern)

4 Microcontrollers and Programming :

Microcontroller vs microprocessor, microcontrollers in embedded systems. Overview of AVR family of microcontrollers, simplified block diagram of AVR microcontroller, General idea of ROM, RAM, EEPROM, I/O pins and peripherals in microcontrollers. AVR architecture and Assembly level programming – General purpose registers, Data memory and instructions, status register and instructions, branch instructions, call and time delay loops; Assembler
directives, sample programs.

Text : (Relevant sections from chapters 1,2 and 3: Textbook 4)

Arithmetic and logical instructions – sample programs. (16 hrs)

Text : (Relevant sections from chapters 5: The Book 4)

5. AVR Programming :

I/O programming, I/O port pins and functions, features of ports A, B, C and D, dual role of Ports, sample programs. I/O ports and bit addressability.

Text : (Relevant sections from chapter 4: Book 4)

AVR programming in C: C language data types for AVR, C programs for arithmetic, logic time delay and I/O operations. (18 hrs)

Text : (Relevant sections from chapter 7: Book 4)

Textbooks:

1. Introduction to Microprocessors–A.P. Ma 6. thur (Tata-McGraw Hill).
2. Fundamentals of Microprocessors and Micro Computers"– B. Ram- Dhanapati Rai
3. Microprocessors – Architecture, Programming and Applications with 8085 - R.S.Gaonkar (Wiley Eastern)
4. The AVR microcontroller and embedded systems – using Assembly and C. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, Prentice Hall - Pearson

Ref: 1. Programming and customizing the AVR microcontroller: Dhananjay V Gadre.

2. Embedded C programming and the Atmel AVR: Barnett, Cox, O'Cull.

Practical for Semesters III & IV

Course Plan

Unit/hours (time required)	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
Unit I (12hours)	Microprocessor as CPU, Internal architecture of Intel 8085, Instruction set, Addressing modes, Examples of Assembly language programming, Addition and subtraction of 2 byte numbers, multiplication and division of 1 byte numbers, Sorting of 1 byte numbers	● Lecture ●Problem-Solving	● Study the Organization and internal architecture of the Intel 8085 ● learn assembly language programming and arithmetic	Evaluation of problems ● Q and A
Unit II (10hours)	Instruction cycles, machine cycles and timing diagram, address space partitioning, generation of control signals for memory and I/O device interfacing, memory interfacing, I/O device interfacing, Address decoding using 74LS138.	● Lecture ●Problem-Solving	● Aware of Memory interfacing, and different Data transfer schemes, CO4 ● Learn interfacing with peripheral I/O devices	● problem solving ● Q and A
Unit III(16hours)	Programmable Peripheral Interface- Intel 8255, Programmable Interval Timer- Intel 8253, Programmable DMA controller- Intel 8257, Programmable Interrupt controller- Intel 8259. ADC interfacing - General idea with block diagram, 7 segment LED display interfacing – General idea of display and drivers.	●Lecture ●Problem-Solving ● Powerpoint presentation	● Learn common applications of microprocessors like E Analog to Digital convert,7 segment LED displays,; Temperature measurement and control using a microprocessor	● Q & A ● Evaluation on problem solving skill

Unit IV (16 hours)	Microcontroller vs microprocessor, microcontrollers in embedded systems. Overview of AVR family of microcontrollers, simplified block diagram of AVR microcontroller, General idea of ROM, RAM, EEPROM, I/O pins and peripherals in microcontrollers. AVR architecture and Assembly level programming – General purpose registers, Data memory and instructions, status register and instructions, branch instructions, call and time delay loops; Assembler directives, sample programs.	● Lecture ●Problem-Solving	● To learn differences between microcontrollers and microprocessors ● To extent the idea of AVR microcontroller	● Q & A ● Evaluation on problem solving skill
Unit V (18hours)	I/O programming, I/O port pins and functions, features of ports A, B, C and D, dual role of Ports, sample programs. I/O ports and bit addressability. AVR programming in C: C language data types for AVR, C programs for arithmetic, logic time delay and I/O operations. .	●Lecture ●Problem-Solving	● To understand the I/O port in an AVR microcontroller ● To learn about AVR programming in C:	● Q & A ● Evaluation on problem solving skill

Faculty in charge
Shyama I

PRACTICALS SEMESTER III & IV

a) PHY3L05 & PHY4L06 (MODERN PHYSICS)

Contact Hours per Week: 8L
Number of Credits:3
Course Evaluation: Internal & External: 1:4

Objectives of the Course:
- Learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- Adopt the skills related to research, education, and industry- academia

Prerequisites: Background of the practical knowledge at degree level.

Course Outline:

External Practical Exam for PHY3L05 & PHY4L06 together will be conducted at the end of 4th semester.
At least 10 experiments are to be done from Part A and 2 each from the elective paper as listed in Part B. If no practicals have been given for a particular elective papers, two more experiments from Part A should be done. It may be noted that some experiments are given both in Part A and B – of course such experiments can be done only once: either as included in part A or in part B. Internal evaluation to be done in each semester and final grades to be intimated to the controller at the end of 2nd and 4th semesters. One mark is to be deducted from internal marks for each experiment not done by the student if the required total number experiments are not done in the semesters. The PHOENIX/EXPEYES Experimental Kit developed at the Inter University Accelerator Centre, New Delhi, may be used for experiments wherever possible.

PART A

1. G.M. Counter plateau and statistics of counting - To obtain the plateau, operating voltage and to verify the distribution law satisfied by the radioactive decay
2. Absorption coefficient for beta & gamma rays -To determine the absorption coefficient of the given materials using a G. M. Counter
3. Feather analysis – End point energy - To determine the end point energy of the beta particles from a given source using Feather analysis
4. Scintillation counter - To calibrate the given gamma ray (scintillation) spectrometer using standard gamma sources and to determine the energy of an unknown gamma ray source
5. Compton scattering - To verify the theoretical expression for the energy of the Compton scattered gamma rays at a given angle using a Scintillation gamma spectrometer / determine the rest mass energy of the electron

6. Half life of Indium – thermal neutron absorption - To determine the half life of In-116 by irradiation of In foil and beta counting using a GM counter
7. Photoelectric effect in lead - To get the spectrum of X rays emitted form lead target by photo electric effect using Cs-137 gammas
8. Conductivity, Reflectivity, sheet resistance and refractive index of thin films
9. Hall effect in semiconductors-To determine the carrier concentration in the given specimen of semiconducting material
10. ESR spectrometer – Determination of g factor
11. Rydberg constant determination
12. Absorption spectrum of $KMnO_4$ and Iodine. To determine the wavelength of the absorption bands of $KMnO_4$ and to determine the dissociation energy of iodine molecules from its absorption spectrum.
13. Ionic conductivity of KCl/NaCl crystals
14. Curie Weiss law -To determine the Curie temperature
15. To study the Thermoluminescence of F-centres of Alkali halides
16. Variation of dielectric constant with temperature of a ferroelectric material (Barium Titanate)
17. Polarization of light and verification of Malu‟s law.
18. Refractive index measurement of a transparent material by measuring Brewster‟s angle
19. Measurement of the thermal relaxation time constant of a serial light bulb.
20. Dielectric constant of a non polar liquid
21. Vacuum pump – pumping speed
22. Pirani gauge – characteristics
23. Ultrasonic interferometer. To determine the velocity and compressibility of sound in liquids.
24. Study of LED characteristics - Determination of wavelength of emission, I-V characteristics and variation with temperature, variation of output power vs. applied voltage
25. Optical fibre characteristics - To determine the numerical aperture, attenuation and bandwidth of the given optical fibre specimen
26. Band gap energy of Ge by four probe method.-To study bulk resistance and to determine band gap energy.
27. Thomson‟s e/m measurement.-To determine charge to mass ratio of the electron by Thomson‟s method.
28. Determination of Band gap energy of Ge and Si using diodes.
29. Millikan‟s oil drop experiment .To measure the charge on the electron.
30. Zener voltage characteristic at low and ambient temperatures – To study the variation of the Zener voltage of the given Zener diode with temperature
31. Thermionic work function – To determine the thermionic work function of the material of the cathode of the given vacuum diode/triode from the characteristic at different filament currents

PART B

I . ADVANCED ELECTRONICS

1. Simple temperature control circuit
2. Binary rate multiplier
3. Optical feedback amplifier
4. Frequency modulation and pulse modulation
5. Binary multiplier
6. Write ALP and execute using 8085 kit for generating a square wave of desired frequency using PPI 8255 interfacing. observe the output on CRO and measure frequency.

7. Write ALP to alternately switch on/off a green and a red LED within a given small time interval. Execute using 8085 kit.
8. Write ALP to convert a given d.c voltage (between 0 and 5 V) using ADC 0800/0808 interfaced to 8085 microprocessor. Execute using the given kit and check the result.

II MATERIAL SCIENCE / CONDENSED MATTER PHYSICS

1. Curie-Weiss law – (To determine the Curie temperature)
2. Solid-liquid phase transitions – measurement of resistivity of metals
3. Growth of a single crystal from solution and determination of structural, electrical and optical properties
4. Study of colour centres – Thermoluminescence glow curves
5. Ionic conductivity in KCl/NaCl crystals
6. Thermoluminescence spectra of alkali halides
7. Thermo emf of bulk samples (Al/Cu)
8. Electron spin resonance
9. Strain gauge – Y of a metal beam
10. Variation of dielectric constant with temperature of a ferroelectric material (Barium titanate)
11. Ferrite specimen – variation of magnetic properties with composition

III COMMUNICATION ELECTRONICS
1. Amplitude modulation and demodulation
2. Frequency modulation and demodulation
3. Pulse amplitude modulation and demodulation
4. Pulse code modulation and demodulation
5. Pulse position modulation and demodulation
6. Study of crystal detector
7. L-C transmission line characteristic
8. Tuned RF amplifier
9. Seely discriminators
10. AM transmitter
11. Radiation from dipole antenna
12. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
13. Optical feedback circuit (Feedback factor, gain and frequency response)

IV. ADVANCED NUCLEAR PHYSICS and RADIATION PHYSICS

1. Half-life of Indium – thermal neutron absorption - To determine the half-life of In-116 by irradiation of In foil and beta counting using a GM counter
2. Alpha spectrometer - To calibrate the given alpha spectrometer and determine the resolution
3. Photoelectric effect in lead - To get the spectrum of X rays emitted from lead target by photo electric effect using Cs-137 gammas
4. Inner bremsstrahlung - To study the intensity spectrum of inner bremsstrahlung from given gamma source
5. Coincidence circuits - To construct and study the performance of series and parallel coincidence circuits using transistors and to determine the resolving time
6. Single channel analyzer - Study of characteristics of a SCA using precision pulser
7. Ionization chamber - Study of variation of pulse height with applied voltage and to obtaing the pulse height

spectrum of X-rays

8. Proportional counter - Study of variation of pulse height with applied voltage and to obtaining the pulse height spectrum of X-rays
9. Track detector – track diameter distribution - To measure the diameters of the alpha tracks in CR-39 track detector
10. Beta ray spectrometer - To plot the momentum distribution of beta particles from given beta sources
11. Range of alpha particles in air and mylar - To determine the range of alpha particles from Am-241 source in air and in mylar using either a surface barrier detector or a GM counter

V EXPERIMENTAL TECHNIQUES

1. Rydberg constant – hydrogen spectrum
2. ESR – Lande g factor
3. IR spectrum of few samples
4. Vacuum pump – pumping speed
5. Vacuum pump – Effect of connecting pipes
6. Absorption bands of Iodine
7. Vibrational bands of AlO
8. Pirani gauge – characteristics
9. Thin films – electrical properties (sheet resistance)
10. Thin films – optical properties (Reflectivity, transmission, attenuation, refractive index)

VI. ELECTRONIC INSTRUMENTATION

1. Strain gauge
2. Simple servomechanism
3. Temperature control
4. Coincidence circuits
5. Multiplexer
6. IEEE 488 Electrical interface
7. Single channel analyzer
8. Differential voltmeter
9. Frequency synthesizer – Signal generator
10. Silicon controlled rectifier – characteristics
11. Silicon controlled rectifier – power control

VII. DIGITAL SIGNAL PROCESSING

1 (a) Compute and plot the cross and auto correlation coefficients of one dimensional signal
(b)Estimate the pitch period of a periodic signal using correlation method. (3 hours).
2 (a) Compute and plot the convolution coefficients of one dimensional signal .
(b)Estimate the pitch period of a periodic signal using the convolution method. (3 hours).
3 Write a program for determining the Linear and circular Convolution of a finite sequence x(n) and h(n).Accept the sequences x(n) and h(n) from the user. Display the output sequence y(n).Plot all three sequences. (3 hours).
4 Compute the N-point DFT of the following. Vary the value of N and visualize the effect with N=8, 16, 24,

64,128,256. (3 hours).
5 Design an N point FIR low pass filter with cutoff frequency 0.2* pi using i) Rectangular ii) Hamming iii) Kaiser windows. Plot for N=16,32,64,128,256.Compare with N=1024 and record your observations. (3 hours).
(The programs are to be executed in Python/MATLAB)

VIII. LASER SYSTEMS, OPTICAL FIBRES AND APPLICATIONS

1. Optical fibre characteristics (Numerical aperture, attenuation and bandwidth)
2. Optical feedback circuit (Feedback factor, gain and frequency response
3. Determination of size of lycopodium particles by Laser diffraction

Reference Books for PHY 305 & PHY 405 :
1. B.L. Worsnop and H.T. Flint – Advanced Practical Physics for students – Methuen & Co (1950)
2. E.V. Smith – Manual of experiments in applied Physics – Butterworth (1970)
3. R.A. Dunlap – Experimental Physics – Modern methods – Oxford University Press (1988)
4. D. Malacara (ed) – Methods of experimental Physics – series of volumes – Academic Press Inc (1988)
5. A.C.Melissinos, J.Napolitano - Experiments in Modern Physics -Academic Press 2003.

Course Plan

Sl. No	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
1 2	G.M. Counter plateau and statistics of counting - To obtain the plateau, operating voltage and to verify the distribution law satisfied by the radioactive decay Absorption coefficient for beta & gamma rays -To determine the absorption coefficient of	• Seminar • Peer Learning • Practicals	• This laboratory course focuses on the advanced physics experiments chosen from Atomic and Molecular Physics, Experimental techniques, Nuclear Physics	• Model Exam • Record Verification • Daily Test

	the given materials using a G. M. Counter		andCommunication Electronics. ● It provides an insight to students about experimental techniques, data analysis, error analysis while investigating physical phenomena. ● This course provides practical knowledge to students as they perform experiments and correlate it to theory.	
3	Hall effect in semiconductors-To determine the carrier concentration in the given specimen of semiconducting material			
4	ESR spectrometer – Determination of g factor			
5	Rydberg constant determination			
6	Absorption spectrum of KMnO4 and Iodine. To determine the wavelength of the absorption bands of KMnO4 and to determine the dissociation energy of iodine molecules from its absorption spectrum.			
7	Band gap energy of Ge by four probe method.-To study bulk resistance and to determine band gap energy.			
8	Thomson‟s e/m measurement.-To determine charge to mass ratio of the electron by Thomson‟s method.			
9	Determination of Band gap energy of Ge and Si using diodes.			
10	Write ALP and execute using 8085 kit for generating a square wave of desired frequency using PPI 8255 interfacing. observe the output on CRO and measure frequency.			

11 12 13 14	Write ALP to convert a given d.c voltage (between 0 and 5 V) using ADC 0800/0808 interfaced to 8085 microprocessor. Execute using the given kit and check the result. Amplitude modulation and demodulation Pulse amplitude modulation and demodulation Ultrasonic interferometer. To determine the velocity and compressibility of sound in liquids.			

Faculty in charge
Ancy Maria Varghese

b) PHY4L07: COMPUTATIONAL PHYSICS PRACTICAL

The programs are to be executed in Python. For visualization Pylab/matplotlib may be used.
At least 10 experiments are to be done, opting any 5 from Part A and another 5 from Part B. The Practical examination is of 6 hours duration.

Part A

1. Interpolation : To interpolate the value of a function using Lagrange's interpolating polynomial
2. Least square fitting :To obtain the slope and intercept by linear and Non-linear fitting.
3. Evaluation of polynomials. Bessel and Legendre functions: Using the series expansion and recurrence relations.
4. Numerical integration : By using Trapezoidal method and Simpson's method
5. Solution of algebraic and transcendental equations .Newton Raphson method, minimum of a function
6. Solution of algebraic equation by Bisection method
7. Matrix addition, multiplication, trace, transpose and inverse
8. Solution of second order differential equation- Runge Kutta method
9. Monte Carlo method : Determination of the value of π by using random numbers
10. Numerical double integration
11. Solution of parabolic/elliptical partial differential equations
(e.g.: differential equations for heat and mass transfer in fluids and solids, unsteady behaviour of fluid flow past bodies, Laplace equation etc.,)

Part B

1. To plot the trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter
2. Generate phase space plots - To plot the momentum v/s position plots for the following systems : (i) a conservative case (simple pendulum) (ii) a dissipative case (damped pendulum)
3. Simulation of the wave function for a particle in a box - To plot the wave function and probability density of a particle in a box; Schrödinger equation to be solved and eigen value must be calculated numerically.
4. Simulation of a two slit photon interference experiment : To plot the light intensity as a function of distance along the screen kept at a distance from the two slit arrangement.
5. Trajectory of motion of (a) projectile without air resistance (b) projectile with air resistance
6. Logistic map function – Solution and bifurcation diagram
7. Experiment with Phoenix/expEYES kit - Time constant of RC circuits by curve fitting. *
8. Experiment with Phoenix/expEYES kit - Fourier analysis of different waveforms captured using the instrument. *
(*If Phoenix is not available, data may be given in tabulated form)
9. Simulation of Kepler's orbit and verification of Kepler's laws.
10. Simulations of small oscillations in simple molecules:: Diatomic molecule/Triatomic molecule for various lengths(any one case)
11. Simulation of random walk in 1D/2D and determination of mean square distance.
12. Simulation of magnetic field - To plot the axial magnetic field v/s distance due to a current loop carrying current.
13. Simulation of the trajectory of a charged particle in a uniform magnetic field.
14. Simulation of polarisation of electromagnetic waves.
15. Simulation of coupled oscillators - Phase space portraits.

Textbooks :

1. Computational Physics -An introduction., R.C.Varma, P.K.Ahluwalia and K.C.Sharma, New Age International
Publishers
2. Numpy Reference guide, http://docs.scipy.org/doc/numpy/numpy-ref.pdf (also, free resources available on net)
3. Matplotlib , http://matplotlib.sf.net/Matplotlib.pdf (and other free resources available on net)
4. Numerical Methods in Engineering and Science, Dr. B S Grewal, Khanna Publishers, New Delhi (or any other
book)
5. Numerical Methods, E Balagurusamy, Tata McGraw-Hill
6. Numerical Methods , T Veerarajan, T Ramachandran, Tat MCGraw-Hill
7. Numerical Methods with Programs I BASIC, Fortran & Pascal, S Balachandra Rao, C K Shantha. Universities
Press
8. Numerical methods for scientists and engineers, K. Sankara Rao, PHI
9. Introductory methods of numerical analysis, S.S.Sastry , (Prentice Hall of India,1983)
10. Numerical Methods in Engineering with Python by Jaan Kiusalaas

Note: Experiments from Part A can be done with data from physical situations wherever possible. For example
consider the following cases.
a) The load W placed on a spring reduces its length L. A set of observations are given below. Calculate force constant and length of the spring before loading
W
(kg) 0.28 0.51 0.67 0.93 1.15 1.38 1.60 1.98
L (m) 6.62 5.93 4.46 4.25 3.3 3.15 2.43 1.46
b) The displacements of a particle at different instants are given below. What is the time instant at which the displacement is 70.2 m
t(s) 1.0 2.2 301 4.5 5.8 6.7 7.6 8.3 9.4
s(m) 3.0 10.56 19.07 37.12 59.16 77.38 98.04 115.78 146.6

Course Plan

Sl. No	Topics to be taught (input)	Procedure (process) Student centric Method of teaching	Activity Learning outcome(output)	Assessment
1	Interpolation : To interpolate the value of a function using Lagrange's interpolating polynomial	• Seminar • Peer Learning • Practicals	• For modern day technology students need to learn programming and Python is a very useful one for Physics students. • In this laboratory course students get the lessons in computer programming using Python.	• Model Exam • Record Verification • Daily Test
2	Least square fitting :To obtain the slope and intercept by linear and Non-linear fitting.			
3	Numerical integration : By using Trapezoidal method and Simpson's method			
4	Solution of algebraic and transcendental equations .Newton Raphson method, minimum of a function			
5	Solution of algebraic equation by Bisection method			
6	Matrix addition, multiplication, trace, transpose and inverse			

7	Solution of second order differential equation- Runge Kutta method			
8	Monte Carlo method : Determination of the value of π by using random numbers			
9	To plot the trajectory of a particle moving in a Coulomb field (Rutherford scattering) and to determine the deflection angle as a function of the impact parameter			
10	Simulation of the wave function for a particle in a box - To plot the wave function and probability density of a particle in a box; Schrödinger equation to be solved and eigen value must be calculated numerically.			
11	Simulation of a two slit photon interference experiment : To plot the light intensity as a function of distance along the screen kept at a distance from the two slit arrangement.			
12	Trajectory of motion of (a) projectile without air resistance (b) projectile with air resistance			
13	Logistic map function – Solution and bifurcation diagram			

Faculty in charge
Ancy Maria Varghese