PGP / PSP 4337 **ASTROPHYSICS** **4hrs/3Cr**

This course offers a comprehensive introduction to astronomy and astrophysics. The students are exposed to evolution of stars and mysterious objects. The models of universe and theories of cosmology are also intended.

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

i. explainthe role of Copernicus, Kepler and Newton in the development of modern astronomy and specify the classification of stars and compute the magnitudes of stars.
ii. describe the working of various types of telescopes and outline the spectral analysis
iii. predict the structure of the sun, its layers and compile types of galaxies and various mysterious objects
iv. analyse the birth and death of stars using H-R diagram and quote the fate of the star using Chandrasekhar's mass limit.
v. ascertain the evolution of universe using different models

Unit I: Positional Astronomy

Development of Astronomy and Birth of Modern Astronomy – Physics of Kepler and Newton – Seasons – Time and Precession – Constellation and nomenclature of stars – Stellar distance – Stellar magnitude – Spectral Classification – Colour index – Aberration and Parallax.

Unit II: Astronomical Observations

Optical telescopes – Types of telescopes – Reflector and refractor type - Recording devices – Photography , Photomultipliers and CCDs. Radio telescope – Interferometers, T, Y and Cross interferometers. Techniques of observation in IR, UV, X – Ray and Gamma ray regions.

Unit III: Sun and Stellar Bodies

Sun as a star – layers of Sun – Photosphere – Chromosphere – Corona – phenomenon of Sun – sun spots – Prominences – solar flares – eclipses – Galaxy – Types of Galaxies – Milky way galaxy – Comets- Asteroids and meteoroids.

Unit IV: Stellar Structure and Evolution:

Basics equations of stellar structure – Nuclear energy sources – Jean's criterion - Star formation – H-R diagram – Main sequence stars – end state of stars – Chandrasekhar mass limit – white dwarfs – Novae and Super novae – Neutron star – Black hole – Binaries and Variable stars.

Unit V: Cosmology

Hubble's law – Models of Universe – The Big-Bang – Steady State theory – consequences of general theory of relativity – Bending of light – Background radiation – Future of the Universe.

Text Books:

1. George O. Abell, *Exploration of the Universe*, Saunders College Publishing, (1986)
2. K.D.Abhyankar, *Astrophysics – Stars and Galaxies*, Tata McGraw Hill Publications, (1989).
3. William Kaufmann, *Astronomy: The Structure of the Universe*, McMillan Publishing Co.inc, New York.(1999).

PGP/PSP 4339 **OBSERVATIONAL ASTRONOMY** **4 hrs / 3 Cr**

This course intends to provide the knowledge on the birth of modern astronomy and views from astronomers. It provides an understanding about the evolution of stars. It also deals with the classification of galaxies.It enables the student to compare and to learn the working principle of different types of telescopes. In addition the course deals with the different theories of universe.

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

i. summarise the birth of modern astronomy from ancient times
ii. describe the theory of birth and evolution of stars.
iii. categorize galaxies based on Hubble classification and distinguish various mysterious objects
iv. compare the different types of telescopes
v. explain different models of origin of universe

Unit I: Birth of Modern Astronomy

Birth of modern astronomy- –Compare and contrast the views of reality held by Plato and Aristotle– universe in the seventeenth century – Kepler's Laws – Newtonian gravitation – seasons – Eclipse – Solar, lunar - solar family.

Unit II: Stellar Evolution

Formation of a star from a cloud of interstellar matter- Birth of low mass stars like our sun, - main-sequence star to a dead star- white dwarf - neutron star - Inventory of the Solar System

Unit III Galactic astronomy:

Milky Way - Hubble classification of galaxies-Spiral galaxies, Elliptical galaxies,Irregular galaxies, Dwarf galaxies – Mysterious objects – Pulsar, Quasar, comets, asteroids - meteors and meteoroids.

Unit IV: Telescopes

Astronomical observations – optical telescopes – Reflecting – refracting – telescope mount – – Radio telescope — UV-IR-X-ray telescopes.

Unit V: Origin of Universe

The Big bang - Formation of Elements, Discovery of the Galaxies, Expansion of the Universe – Hubble's law – steady state – pulsating theory

Text books:

1. Nigel Marshall, *GCSE Astronomy*, IV Edition , Mickledore Publishing, (2010)
2. William J. Kaufmann, *Astronomy: The Structure of the Universe*, Macmillan Publishers Co.,Inc. New York, (1999)

References:

1. Shu F, *The physical universe*, University of California, (1982).

PGP / PSP 4340 **NANO PHYSICS** **4 hrs/3 Cr**

This course is designed to introduce the students to Basic concepts of crystal growth and its application, Characterization adopted in industries and scientific laboratories, Basic concepts of the nano particle. It also deals with Nano structure and its applications, Biological importance of nano materials

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

i. explain the various techniques of crystal growth
ii. discuss the basics of Nanophysics and Methods of synthesis
iii. analyze quantum nanostructure and discuss its applications
iv. describe biological nanostructures, MEMS AND NEMS
v. compute nano particle size and structure using various instruments

UNIT I

Nucleation – Concept of nucleus formation – Shapes of nucleus – Phase diagrams and phase rules – Methods of melt growth – Vapour growth – Slow cooling – Gel growth – Etching techniques.

UNIT II

Introduction to Physics of the Solid State – Structure - Energy Bands - Localized Particles – Metal Nanoclusters- Magic Numbers - Theoretical Modelling of Nanoparticles - Magnetic Clusters – Semiconducting Nanoparticles – Optical Properties - Rare Gas and Molecular Clusters – Carbon Nanotubes – Methods of Synthesis - RF Plasma - Chemical Methods - Pulsed Laser Methods

UNIT III

Preparation of quantum Nanostructure – Size and dimensionality effects – Conduction Electrons and Dimensionality - Properties Dependent on Density of States - Excitons – Single-Electron Tunnelling – Applications – Superconductivity – Self-Assembly – Semiconductor Islands- Monolayers- Process of self-assembly- Catalysis- Porous Materials

UNIT IV

Biological Building Blocks – Nucleic Acids – Biological Nanostructures – Microelectromechanical Systems (MEMSs) – Nanoelectromechanical Systems (NEMSs) – Molecular and Supramolecular Switches

UNIT V

Atomic Structures – Crystallography – Particle Size Determination – Surface Structure – Transmission Electron Microscopy – Field Ion Microscopy – Scanning Microscopy – Spectroscopy of Semiconductors; Excitons – Infrared and Raman Spectroscopy – Brillouin Spectroscopy – Photoemission and X - Ray Spectroscopy – Magnetic Resonance – Luminescence

Text book:

1. P.S. Raghavan and P. Ramasamy, *Crystal Growth Process and Methods*, KRU publications (2000)
2. C.P. Poole Jr, F.J. Owens, *Introduction to Nanotechnology*, Wiley Students Edition (2007)

PGP/PSP 4341 **PHYSICS OF HOME APPLIANCES** **4hrs / 3 Cr**

This course intends to provide an understanding on the basics of electricity and electronics. It enables the student to have a hands-on experience on the usage of multimeter and for soldering the basic components. It also deals with the working principle of different domestic appliances and provides knowledge for maintaining them.

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

i. explain the fundamentals of electricity and electronic components.
ii. implement the skills of testing and servicing the basic equipment of the home appliances.
iii. classify different domestic appliances and explain the physics of appliances
iv. ascertain the maintenance of domestic appliances
v. explain the energy consumption of home appliances

Unit I: Introduction to Electricity and Electronics

Basic Electricity: Voltage, Current, Resistance, Impedance & Power factor -Transformers - Step-up & Step-down - Single phase & Three phase circuits – Fuse, Concept of Earthing
Electronics: Familiarization of electronic components - Capacitor, Choke coil, Diode, Transistor, Thyristor
Basic Equipments for testing and servicing: Multimeter - Measurement of current, voltage and resistance - Checking transistors and diodes in circuit measurements - Soldering Iron - Flux - Lead

Unit II: Heating Appliances

Electric stove - Electric Rice cooker - Toaster - Kettle - Coffee maker -Iron box -Immersion heater - Geyser - Hair drier- Microwave oven

Unit III: Motorised Appliances

Electric fans - Mixer - Grinder/Blenders –Washingmachine - Vacuum cleaner - Domestic water pump - Dish washer

Unit IV: Refrigeration Appliances

Refrigerator: Compressor - coolants - Automatic defrost circuits - Air coolers - Air conditioners

Unit V: Other Appliances

Lights: Incandescent Bulbs, Tubelight, CFL bulb – LED- Voltagestabilizer - Inverters – UPS

Text books:

1. B.L. Theraja& A.K. Theraja, *A Text Book of Electrical Technology*, S. Chand & Company Ltd., New Delhi, India, (2005)

PGP / PSP 4342 **PHYSICS IN HUMAN PHYSIOLOGY** **4 hrs / 3 Cr**

This course enables learners to understand themusculoskeletal system, circulatory system, nervous system, auditory system andmetabolic processes of human body

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

i. describe the behavior of human body under various forces
ii. explain the human functions under gravitational force
iii. identify the physics behind the blood flow in the human body
iv. relate the biological phenomenon to the physics of sound and heat
v. explain the physics of vision

Unit I: Forces and human body

Equilibrium and Stability - Equilibrium Considerations for the Human Body - Stability of the Human Body under the Action of an External Force - Skeletal Muscles - Levers - The Elbow - The Hip - The Back - Standing Tip-Toe on One Foot - Dynamic Aspects of Posture. Standing at an Incline - Friction at the Hip Joint - Spine Fin of a Catfish

Unit II: Motions and human body

Vertical Jump - Effect of Gravity on the Vertical Jump- Running High Jump - Range of a Projectile - Standing Broad Jump - Long Jump- Motion through Air - Energy Consumed in Physical Activity. Forces on a Curved Path - A Runner on a Curved Track - Pendulum - Walking - Physical Pendulum - Speed of Walking and Running - Energy Expended in Running - Alternate Perspectives on Walking and Running - Carrying Loads.

Unit III: Motion of Fluids and human body

Force and Pressure in a Fluid - Pascal's Principle - Hydrostatic Skeleton - Archimedes' Principle - Power Required to Remain Afloat - Buoyancy of Fish - Surface Tension - Soil - Insect Locomotion on Water - Contraction of Muscles – Surfactants.

Viscosity and Poiseuille's Law - Turbulent Flow - Circulation of the Blood - Blood Pressure - Control of Blood Flow - Energetics of Blood Flow - Turbulence in the Blood - Arteriosclerosis and Blood Flow - Power Produced by the Heart - Measurement of Blood Pressure.

Unit IV: Sound / Heat and human body

Energy Requirements of People - Energy from Food - Regulation of Body Temperature - Control of Skin Temperature - Convection - Radiation - Radiative Heating by the Sun - Evaporation - Resistance to Cold - Heat and Soil.

Properties of Sound - Hearing and the Ear - Bats and Echoes - Sounds Produced by Animals - Acoustic Traps - Clinical Uses of Sound - Ultrasonic Waves

Unit V: Optics/Electricity and human body

Vision - Nature of Light - Structure of the Eye - Accommodation - Eye and the Camera - Lens System of the Eye - Reduced Eye - Retina - Resolving Power of the Eye - Threshold of Vision - Vision and the Nervous System - Defects in Vision - Lens for Myopia - Lens for Presbyopia and Hyperopia - Extension of Vision.

The Nervous System- Electricity in the Bone- Electric Fish

Text book:

1. Paul Davidovits, *Physics in Biology and Medicine*, 3rd Edition, Academic press (2008).

Reference books:

1. VasanthaPattabhi and N. Gautham, *Biophysics*, Kluwer academic publishers, (2002).

PGP/PSP 4343 **PHYSICS LAB - I** **9 hrs / 3 Cr**

The laboratory sessions are designed toinculcate good laboratory practice and work habits. This is also a place to reinforce the concepts and techniques presented in the lectures. This course also teaches the students to get acquainted with data and error analysis and offers hands-on experience with moderninstrumentation and soft skills.

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

i. practice systematic laboratory work habits;
ii. design experiments and verify theoretical concepts;
iii. perform Data and error analysis;
iv. handle advanced equipment in the lab;
v. troubleshoot physics experiments.

Total of 16 Experiments:
Compulsory experiments:

1. Fabrication of a dual power supply –regulation study
2. Familiarization of CRO, signal generators
3. Work shop practice – Use of tools and machines.

Any 7 from the following:

4. Familiarization - excel – calculations and graph and PCB software
5. CDS calibration – Na Lamp – Hg spectrum –FabryPerot etalon.
6. Michelson interferometer – Wavelength –Na, Hg & laser.
7. Reflection grating – finding groove spacing- CD, DVD and grating.
8. Calibration techniques - Thermister - Thermocouple
9. linear polarizer & Quarter wave plate - circular and elliptical polarization
10. Eddy current – Electromagnet & mapping the magnetic field.
11. Refractive index of glass, and liquids, sugar content– laser pointer.
12. Fourier series - analyzing periodic function - experiment
13. Balmer series - hydrogen spectrum – Rydberg constant
14. Hartman interpolation formulae – CDS
15. Age of universe - using spectrum and galaxy diagram
16. Channelled spectrum – to determine the thickness of mica sheet

Any 6 from the following:

17. Characteristics of a solar cell- fill factor.
18. Band Energy gap using diode and LED
19. Study of ac circuits – RC, RL, and LCR – using CRO.
20. Use of Digital and Analog Simulation software for solving circuits.
21. Lab View – Data logging
22. Study of charging and discharging of a capacitor.
23. OP-AMP - wave form generator- sine-square-triangle-ramp
24. second order active filter - OP-AMP
25. Timer 555 – a stable, mono stable, bi stable, VCO and Schmidt trigger.
26. Multiplexing and demultiplexing - 4- bit

PGP / PSP 4344 **SUSTAINABLE ENERGY RESOURCES** **4 hrs / 3 Cr**

This course deals with the principles of renewable energy, energy conversion systems, thermal energy systems and energy storage systems.

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

i. distinguish the characteristics of renewable energy.
ii. explain the significance of solar radiation and their applications
iii. explain the energy extraction from wind, tides and organic substances.
iv. describethe thermal energy conversions in ocean and earth's core.
v. interpret different forms of energy storage and their transmission.

Unit I: Principles of Renewable Energy

Fundamentals - Scientific principles of renewable energy - Technical implications - Social implications - Heat transfer - Heat circuit analysis and terminology - Conduction - Convection - Radiative heat transfer - Properties of transparent materials - Heat transfer by mass transport.

Unit II: Solar Energy Systems

Solar radiation - Measurements of solar radiation- Solar water heating - Evacuated collectors - Solar ponds - Solar concentrators - Solar thermal electric power systems –Photo-voltaic generation - Solar radiation absorption - Types of photo-voltaicsystemsand their Applications

Unit III: Energy Conversion Systems

Power from the wind - Turbine types and terms - Characteristics of the wind - Power extraction by a turbine - Electricity generation - Mechanical power - Biomass and biofuels - Biofuel classification - Biomass production for energy farming - Direct combustion for heat - Pyrolysis (destructive distillation) - Anaerobic digestion for biogas - Vegetable oils and biodiesel - Tidal power - The cause of tides - Tidal current/stream power - Tidal range power.

Unit IV: Thermal Energy Systems

Ocean thermal energy conversion (OTEC) - Principles - Heat exchangers - Pumping requirements - Environmental impact - Geothermal energy - Geophysics - Dry rock and hot aquifer analysis - Harnessing Geothermal Resources.

Unit V: Energy Storage Systems

Energy systems, storage and transmission - The importance of energy storage and distribution - Biological storage - Chemical storage - Heat storage - Electrical storage: batteries and accumulators - Fuel cells - Mechanical storage.

Text Book:

1. John Twidell and Tony Weir, *Renewable Energy Resources*, 2nd edition, London, Taylor & Francis Group, (2006).

PGP / PSP 4346 **PHYSICS LAB - II** **9 hrs / 3 Cr**

The laboratory sessions are designed to inculcate good laboratory practice and work habits. This is also a place to reinforce the concepts and techniques presented in the lectures. This course also teaches the students to get acquainted with data and error analysis and offers hands-on experience with modern instrumentation and soft skills.

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

i. practice systematic laboratory work habits.
ii. design experiments and verify theoretical concepts
iii. perform Data and error analysis
iv. handle advanced equipment in the lab
v. troubleshoot physics experiments

Total of 16 Experiments: **Any 8 from the following:**

1. Hall Effect - Hall coefficient, Hall voltage, carrier density and mobility.
2. GM counter - counter plateau and resolving time
3. CDS - arc spectrum
4. Michelson interferometer - optical bread board - refractive index of gas
5. Ultrasonic interferometer - Physical parameters of pure and binary liquids - dielectric constant, verification of iterative equations
6. XRD – Determination of structural parameters
7. Determination of Hysteresis loss – tracing B-H loop on the CRO
8. Free fall – displacement-time graph, g calculation using charging and discharging
9. Four probe - Measurement of sheet resistance, resistivity, Energy gap -thin films, silicon & aluminum foil.
10. Susceptibility - electro magnet - Quinke's method – liquid
11. Microwave - Characteristics, dielectric constant in liquid and solids
12. Thick lens systems – nodal points – optical bench
13. Charge of the electron - using spectrometer.
14. MATH-CAD – Graphics and Mathematical analysis

Any 8 from the following:

15. Pulse Width Modulation - Study & DC motor control.
16. Op-Amp - logarithmic and Anti logarithmic amplifier, current to voltage converters and voltage to current converters
17. FM Modulation and demodulation.
18. Experiments in physics with expEYE-17.
19. Lab view –multiplexer and demultiplexer
20. Stepper motor control - using micro controller.
21. Design of counters – using flip flops, MOD counters using 7490.
22. FET – characteristics – Vp, I_{DSS}, gm, rd.
23. Analog computation using - OP-AMP.
24. D/A conversion - (R-2R and weight network).
25. Instrumentation amplifier.
26. Study of RAM – using ICs.

PGP/PSP 4433 **MATHEMATICAL PHYSICS - I** **4 hrs / 4 Cr**

This course helps to understand the complex variables and acquire knowledge about special functions and series solutions of differential equations in physics. Students get basic concept about Fourier series and integral transforms also familiarizing withnumerical methods and to impart mathematical knowledge for the description of physics phenomena

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

i. explain the characteristics of complex functions, evaluate residues and definite integrals.
ii. describe the properties and usage of special functions in physics
iii. elucidate the characteristics of orthogonal polynomials

iv. expand the periodic functions using Fourier series and apply integral transforms
v. solve polynomials, integral and differential equations using numerical methods.

Unit I: Complex Variable

Functions of a complex variable – analytic function – Cauchy-Riemann conditions - Cauchy's integral theorem and integral formula - Taylor's and Laurent's expansions - Cauchy residue theorem – Evaluation of residues - Evaluation of definite integrals

Unit II: Special Functions in Physics

Gamma functions – Beta functions – Dirac-Delta functions – Green's functions- One dimension – Two and three dimension - Applications of Green's functions.

Unit III: Series Solutions of Differential Equations in Physics

Differential equations, Generating function, Rodrigues' formula Recurrence relations and Orthogonality of Bessel, Legendre, Hermite and Laguerre polynomials

Unit IV: Fourier series and Integral Transforms

Fourier series - Application of Fourier series - Fourier Integral theorem - Fourier Transform – Convolution theorem – Parseval's relation – Transforms of derivatives - Application of Fourier transform - Laplace transform - Application of Laplace transform.

Unit V: Numerical Methods

Roots of polynomial and transcendental equations - Newton-Raphson method - Lagrange's interpolation - Numerical integration - Trapezoidal, Simpson's method - Euler's method, Runge-Kutta method

Text Books:

1. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc, (2008)
2. George B. Arfken and Hans J. Weber, *Mathematical Methods for Physicists*, Elsevier Academic Press Seventh Edition, (2012)
3. M.K. Venkataraman, *Numerical Methods in Science and Engineering*, National Publishing Co, Fifth Edition, (1999)

PGP / PSP 4434 INSTRUMENTATION & MICROCONTROLLERS 5 hrs/4Cr

This course enables the students to learn the fundamentals of system design and instrumentation and to study its characteristicsand applications. This course gives the fundamental knowledge of signal processing. This course also introduces the students to know the basics of microcontroller and to write simple programs.

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

i. analyze the fundamentals of system design and instrumentation.
ii. elucidate the characteristics and applications of transducers
iii. explain the fundamentals of signal processing
iv. describe the architecture and the instruction sets of microcontroller
v. explain the different interfaces related to microcontroller

Unit I: Generalized Characteristics of Instruments & Error

Static characteristics: Accuracy – precision-repeatability – resolution – sensitivity – linear and non linear systems – drift – span – range - noise and filtering - loading effect- Dynamics characteristics: Transfer function – response of first and second order instruments to standard inputs - dead – time elements. Measurement- need for measuring errors in physics - types, measurement and propagation of errors- linear and non -linear curve fitting– least square fitting – Goodness of fit – chi squares fitting

Unit II:Transducers

Introduction – Classification of transducer – Potentiometer - linear measurement – strain gauge – thermistor – thermocouples –capacitive transducers – thermoelectric transducers – Piezo electric transducers - characteristics and applications.

Unit III: General measurements and signal processing

Pressure / vacuum transducers - Measurement of time and energy –Signal conditioning and recovery, impedance matching, amplification (Op-amp based, instrumentation amp, feedback), filtering and noise reduction, shielding and grounding; Fourier transforms; lock-in detector, box-car integrator.

Unit IV: Microcontroller:

PIC18FXX2 Microcontroller Introduction- Architecture- memory organization-registers-addressing modes-data transfer and control instructions-basic arithmetic instructions-logic instructions-assembly language programs-embedded C programs

Unit V: Operations and Applications

PIC18FXX2 Microcontroller I/o Operations and Applications - Interrupts- Timers- PWM – UART - I2C bus - SPI interface – USB - A/D Conversion - D/A Conversion - frequency measurement - temperature measurement - Stepper motor control.

Text Books:

1. A.K.Sawney, *Electrical and electronic measurements and instrumentation*, Dhanpat Roy and co, (2005)
2. Robert B. Reese, *Microprocessors from assembly language to C using PIC18FXX2*, Shroff publishers and distributors, (2005)

PGP/PSP 4435 <u>CONDENSED MATTER PHYSICS – I</u> 4 hrs / 4 Cr

This course exposes students to have a detailed discussion on different crystal structures, various diffraction techniques and different imperfection in crystals; it also deals with the different bonding natures in crystals. It also attempts to have a systematic approach to problem solving in crystal vibrations.

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

i. determine the structure factors and atomic scattering factor of crystal lattices.
ii. describe the X-ray diffraction and anomalous dispersion to predict the crystal structure and temperature effects
iii. classify and differentiate the defects in crystals.
iv. explain and relate different crystal binding forces.
v. describe and examine the effect of lattice vibrations.

Unit I: Crystallography
Basic concepts of crystallography-Index system for crystal planes –Simple crystal structure – Reciprocal lattice vectors – Fourier analysis of the basis: Structure factor for SC, BCC, FCC structures – Atomic scattering factor- Quasi crystals.

Unit II: Crystal diffraction
Braggs law – different scattering methods-derivation of scattered wave amplitude -anomalous dispersion of scattering by crystals- Theory of X-ray diffraction-temperature effect- crystal structure determination

Unit III: Crystal imperfections
Imperfections in crystals –Point defects: Lattice vacancies- Diffusion- Colorcenters- Surface and interface physics: Concentration of Frenkel and Schottky defects – Line imperfections – Screw imperfection – Burger vector – Surface imperfections – volume defects-Dislocations.

Unit IV: Crystal binding

Crystals of inert gas – van der Walls interactions – Repulsive interaction – Equilibrium lattice constants – Cohesive energy – Ionic crystals – Madelung energy – Evaluation of Madelung constant – Covalent, Metallic and Hydrogen bonding – elastic strain components

Unit V: Crystal vibrations

Vibrations of crystal with monoatomic basis – group velocity – Two atoms per basis – Quantization of elastic waves – Phonon momentum – Phonon heat capacity – Debye theory of specific heat – Debye T^3 law – Anharmonic crystal interactions

Text Book:

1. Charles Kittel, *Introduction to Solid State Physics*, 5th edition, (1993).

References:

1. S.O. Pillai, *Solid State physics*, New age international (P) limited (1997).
2. Ali Omar, *Elementary Solid State Physics*, Pearson Education India, (2000).
3. H.V Keer, *Principles of Solid State*, Wiley Eastern Lmt. (1994)
4. M.A.Wahab, *Solid State Physics*, Narosa Publishing house, Delhi, (1999)

PGP / PSP 4436 **MATHEMATICAL PHYSICS - II** **4 hrs / 4 Cr**

This Course introduce linear vector, matrices, Tensors, probability and group theory by exploring mathematical behaviour in physics. Students familiarize themselves with the importance and uniqueness of mathematical tools to analyse physics phenomenon.

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

i. explain the properties of linear vector space and matrices and apply them to analyze a broad range of physical models
ii. apply the concepts of Tensor analysis and Tensor calculus to formulate physical laws and simplify them using coordinate transformations
iii. apply probability and statistical laws to physical problems
iv. explain basic concepts in group theory and its importance in physics
v. usecharacter table and group symmetry to form irreducible representations

Unit I: Linear Vector Space and Matrix Analysis

Definition of a linear vector space – Linear independence, basis – Scalar product – Orthonormal basis – Gram-Schmidt orthogonalization process – Linear operators. Special matrices – Eigen values and Eigen vectors – Cayley Hamilton theorem – Coordinate transformations.

Unit II: Tensors Analysis

Introduction – Transformation of Coordinates – Contravariant and Covariant tensors - Algebra of tensors – Quotient law – The line element – Fundamental metric tensor – Associate tensors.

Unit III: Tensors Calculus and Probability

Christoffel symbols – Covariant differentiation of tensors – Equation of the Geodesic line – Riemann-Christoffel tensors. Elementary probability theorem – random variables – Binomial, Poisson and Normal distributions

Unit IV: Abstract Group Theory

Definition and nomenclature – multiplication table – Rearrangement theorem – Cycle groups – Sub-groups – Cosets, class – Normal divisors and factor groups – Class multiplication - Continuous groups – SU(2) and SU(3) – Orthogonal.

Unit V: Theory of Group Representation

Reducible and irreducible representation – Great orthogononality theorem (no proof) – Character representation – Character table decomposition of reducible representation – Regular representation – Application of representation theory

Text Books:

1. P.K.Chattopadhyay, *Mathematical Physics*, New Age International Publishers (2013).
2. Charlie Harper, *Introduction to Mathematical Physics*, Prentice-Hall, Inc (1976),
3. Louis A. Pipes and Lawrence R. Harvill,*Applied Mathematics for Engineers and Physicists*, McGraw-Hill, International Third Edition (1970)
4. A.W.Joshi, *Elements of group theory for physicists*, New Age International Publishers (1997),

PGP / PSP 4438 **QUANTUM MECHANICS - I** **4 hrs / 4 Cr**

This course deals with the basics of quantum mechanics, exactly solvable eigenvalue problems, theory of angular momentum, and scattering theory.

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

i. describe and apply the concepts of quantum mechanics to exactly solvable systems
ii. explain the general formalism of wave mechanics.
iii. find the energy eigen functions and eigen values of bound state systems
iv. describe the theory of general angular momentum and its applications
v. elucidate the quantum theory of scattering in low energy and high energy approximations.

Unit I: The Schrodinger Equation and Stationary States

A Free particle in One Dimension – Generalization to Three Dimensions – The Operator Correspondence and the Schrodinger Equation for a Particle Subject to Forces – Normalization and Probability Interpretation – Non- normalizable Wave Functions and Box Normalization – Conservation of Probability – Expectation Values : Ehrenfest's Theorem – Admissibility Conditions on the Wave Function – A Particle in a Square Well Potential – Square Potential Barrier – Delta-Function Well

Unit II: General Formalism of Wave Mechanics

The Fundamental Postulates of Wave Mechanics – The Eigenvalue Problem: Degeneracy – Observables: Completeness and Normalization of Eigenfunctions – Closure – Physical Interpretation of Eigenvalues, Eigenfunctions and Expansion Coefficients – The Uncertainty Principle – States with Minimum Value for Uncertainty Product – Commuting Observables: Removable Degeneracy.

Unit III: Exactly Solvable Eigenvalue Problems

The Simple Harmonic Oscillator – Analytical Method – The Abstract Operator Method – Angular Momentum and Parity – Eigenvalue Equation for L^2: Eigenvalues and

Eigenfunctions – Spherical Harmonics – The Hydrogen Atom – Solutions of the Radial Equation: Energy levels – Stationary State Wave functions - Charged particle in a uniform magnetic field – Integer Quantum Hall Effect.

Unit IV: Angular Momentum

The Hilbert Space of State Vectors: Dirac notation – Representation of Dynamical Operators – Unitary Transformation - The Eigenvalue Spectrum – Matrix representation – Spin Angular Momentum – A Charged particle in a uniform magnetic field - Non-relativistic Hamiltonian with Spin : Diamagnetism – Addition of Angular momenta – Evaluation of C. G. Coefficients - Spin Wave functions for a system of two spin-1/2 particles - Identical Particles with Spin.

Unit V: Scattering Theory

Kinematics of the Scattering Process – Wave Mechanical Picture of Scattering – Green's functions: Formal Expression for Scattering Amplitude – The Born Approximation; Partial Wave Analysis – Phase Shifts – The Scattering Amplitude in terms of Phase shifts – The Differential and Total Cross-Section: Optical Theorem – Phase shifts: Relation to Potentials – – Scattering by a Square Well, Hard Sphere;

Text Book:

1. P. M. Mathews & K. Venkatesan, *A Text Book of Quantum Mechanics*, 2nd Ed., Tata McGraw Hill, New Delhi (2013)

PGP / PSP 5431 NUCLEAR & PARTICLE PHYSICS 5 hrs / 4 Cr

This course enables students to acquire knowledge of basic properties of nucleus and the nature of nuclear forces. It introduces the concepts of radioactivity and students get an insight into nuclear reactions. Also it helps students to gain the knowledge on elementary particles.

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

i. explain the structure of nucleus, its stability and various nuclear models
ii. categorize various nuclear decay process and the associated selection rules
iii. discuss the nature of nuclear forces
iv. elucidate key features of nuclear fission reactors and fusion reactions
v. classify elementary particles and quark states using group theory

Unit I: Nuclear Structure and Models

Nuclear size –theories of nuclear composition-binding energy- semi empirical mass formula of Weizsacker - nuclear stability – Fermi gas model – liquid drop model – shell model - magic numbers - extreme single particle model- predictions of shell model- Unified model.

Unit II: Radioactivity

Geiger Nuttal law- fine structure of alpha spectra- Gamow's theory of alpha decay- beta decay- Neutrino hypothesis- Fermi's theory of beta decay- Kurie plots- Fermi and G.T.Selection rules- Non- conservation of parity in beta decay- Gamma emission- internal conversion- nuclear isomerism.

Unit III: Nuclear Scattering and Reactions

Nuclear forces-deuteron-low energy n–p scattering- phase shift, scattering length- p-p scattering at low energies- n-n scattering- types of nuclear reactions-Conservation laws- Q-equation- endoergic and exoergic reactions- nuclear cross section-Breit- Wigner one level formula- Direct reactions

Unit IV: Nuclear Fission and Fusion

Nuclear fission: types of fission-fission cross section- fission isomer-deformation of liquid drop-Bohr and Wheelers theory of nuclear fission-parity violation in fission- nuclear fusion and thermonuclear reactions- controlled thermonuclear reactions-nuclear fission reactor: nuclear chain reaction-four factor formula-critical size of a reactor.

Unit V: Elementary Particles

Introduction- classification of elementary particles- fundamental interactions- conservation laws- conservation of isospin- strangeness- hypercharge-Gell-Mann Nishijima relation-charge conjugation- parity- Combined Inversion- time reversal- combined inversion of CPT-neutrino and antineutrino-graviton, photon and gluon-elementary particle symmetry- SU(2) group- SU(3) group- quarks model.

Text Books:

1. D.C.Tayal, *Nuclear Physics*, Himalaya Publishing house, New Delhi (2013)

PGP/PSP 5432 **<u>THIN FILMS & VACUUM TECHNOLOGY</u>** **4 hrs/4 Cr**

This course introduces students to the theory and practice of high vacuum systems as well as thin film deposition. Students will have hands on experience of system operation, thin filmcoating and design. This course also introduces the students to various characterization techniques adopted in industries and scientific laboratories.

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

i. identify and explain different high vacuum system and its components
ii. distinguish between different types of coating procedures
iii. explain the physics of thin film growth
iv. analyze and interpretthe characteristics of thin film
v. describe the properties and applications of thin films

UNIT I: Production of High Vacuum

Production and maintenance of high and ultrahigh vacuum systems - Kinetics of vacuum - Low and high vacuum – high vacuum materials - Gas transport - conductance - pumping - Vacuum pumps - vacuum gauges -types of valves and flanges - Types of vacuum systems and their components - types of leakages. system switching ON and OFF procedure.

Lab: Pump down characteristics, flow rate determination, McLeod's gauge,Identifyingtypes of valves and flanges.

UNIT II: Physical evaporation Process

Physical vapour deposition - evaporation rate - Evaporation of alloys- Film thickness uniformity and purity- Thermal evaporation - source heaters - substrate materials and cleaning - Glow discharge - plasma species - Sputtering systems, its types - sputter yield - alloy sputtering - RF sputtering - PLD process and coating - Evaporation Vs Sputtering.

Lab: Demonstration of thermal and sputtering coating- Hard coatings

Unit III: Growth and Chemical Coating Process

Film formation and structure: growth process- basic models - kinetic models of nucleation - theory of homogeneous and heterogeneous nucleation - nucleation rate - sticking coefficient - compar. **Chemical vapour deposition** - Reaction types - CVD process and systems - Low and high temperature systems - LPCVD, PECVD, LECVD, MOCVD - safety.

Unit IV: Surface and thickness of thin films

Film thickness - micro balance - quartz crystal monitor - Profilometer (stylus) - ellipsometry - photometric method- spectro photometric method - FIZEAU and FECO methods - structural analysis, LEED, HEED, SEM, TEM, AES, EDAX and XPS (Description only).

Lab:–Thickness measurement usingmicrobalance, quartz crystal, profile meterandFizeau method.

Unit V: Properties and application of thin films

Hardness and corrosion of thin films - adhesion test -hard and protective coatings.Electricalproperties - General definitions - film resistivity - four probe, Conduction and TCR of continuous and discontinuous thin films. Optical properties - General definitions - non absorbing films - one and two interfaces - Absorbing films. Thin film resistors– antireflection coatings – Transparent conducting coatings.

Lab: study of reflection, transmission curves of UV-visible spectrophotometer & determination of n and k values – Optical E_g determination - E_g of thin films four probe method.

Text Books:

1. Milton Ohring, 2006, *The material science of thin films*, 2ed , Academic press limited.

2. K. L Chopra 1969, *Thin film phenomena,* McGraw hill book company.
   Chapter II, III, IV, V VI, XI relevant topics.

References:

1. Andrew Guthrie, 1963 "*Vacuum technology*" John Wiley& sons, Inc.

PGP/PSP5433 ELECTRODYNAMICS AND PLASMA PHYSICS 4 hrs/4 Cr

To apprise the students regarding the concepts of electrodynamics and Maxwell equations and use them various situations. Also the course introduces the students to elementary phenomena and concepts in plasma physics.

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

i. describe electrostatic phenomenon using method of images and boundary value approach
ii. explain magneto-statics phenomenon and construct Maxwell's equations
iii. describe propagation of electromagnetic waves in different media using Maxwell's equations
iv. elucidate the production of electromagnetic waves and derive the relativistic electro dynamic field equations
v. explain elementary phenomena and concepts in plasma physics.

UNIT I: Electrostatics

The Electric field – Differential form of Gauss Law – Applications of Gauss Law – Poisson's Equation and Laplace's Equation- The Method of Images - Boundary Value Problems – Multipole Expansion - Electric fields in Matter – Polarization – Bound Charges – Electric Susceptibility - Boundary value problems with linear dielectrics

UNIT II Magneto statics& Maxwell's Equations

The Biot-Savart Law – The Divergence and Curl of Magnetic field – Ampere's Law – Magnetic Vector Potential – Magnetic Fields in Matter – Magnetization - Bound Currents – Magnetic Susceptibility – Maxwell's Equations: Electrodynamics Before Maxwell - Magnetic Charge - Maxwell's Equations in Matter - Boundary Conditions-Electromagnetic waves in Vacuum - The Wave Equation for E and B - Monochromatic Plane Waves - Energy and Momentum in Electromagnetic Waves -

UNIT III Propagation of EM Waves

Electromagnetic Waves in Matter – Propagation in Linear Media - Reflection and Transmission at Normal Incidence and Oblique Incidence – Fresnel's equation - Electromagnetic Waves in Conductors - Reflection at a Conducting Surface - Wave Guides - TE Waves in a Rectangular Wave Guide - The Coaxial Transmission Line

UNIT IV Radiation of EM Waves & Relativistic Electrodynamics

Dipole Radiation: Electric Dipole Radiation - Magnetic Dipole Radiation – Radiation from an Arbitrary Source - Electric and Magnetic fields and Total Radiated Power - Point Charges - Power Radiated by a Point Charge; **Relativistic Electrodynamics** - The Field Tensor – Electrodynamics in Tensor Notation - Relativistic Potentials – Maxwell's equations.

UNIT V: Introduction to Plasma Physics

General Properties of Plasma – Debye Shielding – The Occurrence of Plasma in Nature - Applications of Plasma Physics: Controlled Thermonuclear Fusion – The Magneto-hydrodynamic Generator – Plasma Propulsion – Plasma Devices – Theoretical Description of Plasma Phenomena; Charged Particle Motion in Non-uniform magneto-static fields: Gradient Drift – Magnetic Mirror Effect.

Text Books:

1. J. H. Griffiths, 3rd ed., *Introduction to Electrodynamics*, Prentice-Hall of India Pvt Ltd, New Delhi (2013).
2. J. A. Bittencourt, *Fundamentals of PLASMA PHYSICS*, 3rd Ed., Springer-Verlag, NewYork (2004)

PGP/PSP 5434 **CONDENSED MATTER PHYSICS – II** **4 hrs/4 Cr**

This course enables learners to acquire knowledge of energy bands in crystals, understand the different classification of materials, translate the learned information to a variety of quasi particles, present reasoned explanation for various superconducting effects and apply the systematic approach to problem solving in dielectrics and Ferro electrics

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

i. derive and explain the electrical properties of crystals
ii. explain the theory of quasi particles and their characteristics
iii. classify the types of superconductors and explain its properties
iv. explain the origin of dielectric and Ferro-electric phenomena
v. describe quantum theory of magnetism and classify magnetic materials

Unit I:Fermi Gas and Energy Bands:

Free electron theory in 1D and in 3D – Fermi-Dirac distribution – Density of states – Heat capacity of the electron gas – Electrical conductivity and Ohm's law – Motion of electrons in magnetic field – Hall Effect – Nearly free electron model – Bloch functions – Kronig-Penney model.

Unit II:Plasmons, Polaritons, Polarons and Excitons

Dielectric function of the electron gas – Plasma Optics – Transverse and Longitudinal modes of Plasma – Plasmons – Polaritons – LST equation – Polarons, Optical Reflectance-Kramer-Kronig relation –Excitons- Frenkel and Mott-Wannierexcitons

Unit III:Superconductivity:

Experimental survey – Destruction of superconductivity by magnetic field – Meissner effect – Isotopic effect – Type I and Type II superconductors – London equation – Coherence length – BCS theory of superconductivity – Flux quantization – Vortex state – DC and Ac Josephson effect – High temperature superconductors – Fullerenes

Unit IV:Dielectric and Ferro electrics

Macroscopic electric field – Local electric field at an atom – dielectric constant and Polarizability – Classius-Mossati equation – electronic polarizability and its frequency dependence – Structural phase transitions – Ferro electric crystals – Displacive transition – Landau theory of phase transition – antiferroelectric materials –Piezoelectricity-Ferroelasticity

Unit V:Magnetism

Quantum theory of dia and para magnetism- Rare earth ions- Hund's rule- Orbital quenching-Paramagnetic susceptibility of conduction electrons- Ferromagnetic order- antiferromagnetic order- Magnons, thermal excitons of magnons , spin waves

Text Book:

1. Charles Kittel, *Introduction to Solid State Physics*, 5th edition.

References:

1. S.O Pillai(1997), *Solid State Physics*, Wiley Eastern Lmt.
2. S.V Subramanian, E.S Rajagopal(1989), *High Temperature Super conductivity*, Wiley Eastern Lmt
3. H.V Keer(1994), *Principles of Solid State,* Wiley Eastern Lmt.
4. M.A.Wahab(1999), *Solid State Physics*, Narosa Publishing house, Delhi

PGP/PSP5435 **PHYSICAL ELECTRONICS** **4 hrs / 4 Cr**

This course aims to provide students with knowledge of conduction in electronic devices, the theory behind conduction mechanism, Field effect transistors, microwave devices and photonic devices.

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

i. explain the phenomena of conduction in metals
ii. describe electrical conduction in semiconductors
iii. account for charge transport across semiconductor junctions
iv. describe the operations of FET and microwave devices
v. elucidate the physics of photonic devices

UNIT-1 Conduction in metals

Electron volt - unit of energy - current density - motion in a magnetic field - Nature of the atom - energy band theory of crystals - insulators - semiconductors - conductors- Conduction in metals - potential energy field in a metal - bound and free electrons - energy density - Fermi level -density of states - work function .

UNIT-2 Theory of semiconductors

Conduction in semiconductors - electrons and holes - conductivity - carrier concentration in conduction and valence band - intrinsic concentration- effective mass - fermi level in an intrinsic and extrinsic semiconductor - donor acceptor impurity - charge density in a semiconductor - Diffusion - carrier life time - The continuity equation- Hall effect.

UNIT-3 Semiconductor Diode

Semiconductor diode characteristics - qualitative theory - P-N junction as a diode - Metal-semiconductor junctions, Schottky diode- ohmic contacts - open circuited p-n junction. Theory of p-n diode forward and reverse currents - the volt-ampere characteristics - diode resistance - transition and diffusion capacitance

UNIT-4 FET and microwave Devices

JFET- construction - characteristics - small signal model - FET as voltage and current regulator - homo and hetero junction devices - the MOSFET transistor, CMOS technology, the UJT - frequency dependence and applications. Tunnel - Gunn diode - IMPATT diode - Klystron - travelling Magnetron and back ward oscillators - working, characteristics and applications.

UNIT-5 Physics of Photonic Devices

Basic monolithic circuits - monolithic diode - integrated resistor - integrated capacitors and inductors - Radiative and non-radiative transitions - optical absorption- photo emissivity - photo tubes - photo multiplier tubes - photo conductivity - photo diode - laser diode - photo voltaic effect - solar cell - photo detectors - LED- OLED.

Text Books:

1. Christos C. Halkias, SatyabrataJit, Jacob Millman, (2015) *Electronic devices and circuits*, 4e ,Mcgraw hill publishing company.

PGP/PSP 5436 **ANALOG ELECTRONICS** **4 hrs/4 Cr**

This course enables the students to understand mainly the operational amplifier in detail and to analyse the different modes of operation.
At the end of the course, students will be able to

i. interpret the theory behind the modes of operation
ii. analyse theoretically, the different types of filters and their characteristics
iii. describe the non-linear models of operational amplifiers
iv. design and explain oscillator circuits
v. explain the limitations in the use of operational amplifier and apply it for constructing amplifiers and oscillators.

Unit I: OP-AMP Introduction

Amplifier fundamentals - Ideal OP-AMP model-frequency response OP-AMP testing circuit - impact of virtual ground - difference amplifier - negative feed -back-real inverting OP-AMP - real non-inverting OP-AMP

Unit II: Active Filters

Transfer function - Bode plot-first order low pass filter - first order high pass filter-first order band pass filter –band reject filter- second order responses - Salen-key second order low pass filter - KRC second order low pass filter - Salen-key second order high pass filter - KRC second order high pass filter - second order band pass filter.

Unit III: Non linear circuits

Positive feed - back - voltage comparator - threshold detector - level detector -window detector - pulse width modulation - Schmitt trigger - inverting Schmitt trigger - non-inverting Schmitt trigger - Analog switches - peak detector - sample and hold circuits.

Unit IV: Signal Generators

Practical Wien's bridge oscillator - multi-vibrators - CMOS Gate multi-vibrator -CMOS crystal oscillator - voltage controlled oscillator - Triangle to sine wave converter.

Unit V: Limitations and Applications

Input bias-offset current-low input bias-input offset voltage-low input offset voltage OP-AMPs-slew rate limiting-current to voltage converter-photo detector amplifier-charge amplifier-Instrumentation amplifier-transducer bridge amplifier-log amplifier-anti log amplifier

Text Book:

1. Sergio Franco, *Design with Operational Amplifiers and Analog Integrated Circuits*, McGraw - Hill Book Company, 4th Edition (2014).

PGP/PSP 5437 **LASER & SPECTROSCOPY** **4 hrs/ 4 Cr**

This Course deals with the basic physics behind laser operation, the different laser systems and their applications like interaction with matter and information processing. Physical and Chemical processes in molecular systems are also analyzed through various spectroscopic methods in different regions of electromagnetic spectrum.

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

i. explain the theory of lasers and its line broadening mechanism.
ii. describe the design characteristics of optical cavities for laser systems.
iii. elucidate rotational and vibrational spectroscopy
iv. discuss Raman and electronic spectroscopy
v. describe the theory ofresonance spectroscopy

UNIT I: LASER - I

Einstein Coefficients – Light amplification – Threshold condition – Laser rate equations – Three level system – Four level system – Variation of laser power around threshold – Optimum output coupling – Line broadening mechanisms.

UNIT II: LASER - II

Modes of a rectangular cavity and the open planar resonator – Quality factor – Ultimate line width of a laser – Mode selection – Q - Switching – Mode locking in lasers – Modes of a confocal resonator system

UNIT III Rotational and Vibrational Spectroscopy

Types of molecules – Rotational spectra of rigid and non-rigid rotators – Intensity of rotational lines– Effect of isotopic substitution –Stark modulated microwave spectrometer – Vibrational spectra of simple harmonic oscillator – Anharmonic oscillator – vibrating rotator – IR Spectrometer.

UNIT IV: Raman and Electronic Spectroscopy

Classical and quantum theory of Raman effect – Pure rotational Raman Spectra – Vibration Raman spectra – Raman activity of vibrations – Raman spectrometer – Vibrational coarse structure – Frank Condon principle – Rotational fine structure – Dissociation and pre dissociation – Deslander's table – Fortrat parabola – Photo-electron spectroscopy.

UNIT V: Resonance Spectroscopy

Interaction of spin and applied magnetic field – Relaxation processes – Chemical shift – Coupling constant – NMR spectrometer – Principles of electron spin resonance – Multiplet structure – ESR spectrometer - Mössbauer effect – Recoilless emission of gamma rays.

Text Books:

1. A.K. Ghatak& K. Thyagarajan, *Optical Electronics*, Cambridge University Press, Cambridge, (1989).
2. G.N. Banwell& E.M. Mccash, *Fundamentals of Molecular Spectroscopy*, 4th Ed. Tata McGraw Hill Publishing, (2000).

PGP/PSP 5439 **QUANTUM MECHANICS -II** **4 hrs/4 Cr**

This course gives an insight of applying different approximation methods for stationary states and deals with alternative pictures of time evolution and relativistic quantum mechanics. It also helps the students to acquire basic knowledge of quantum field theory.

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

i. apply different approximation methods for stationary states.
ii. describe the time evolution of quantum systems and discuss matter radiation interaction
iii. differentiate Schrodinger, Heisenberg and Dirac pictures and quantum theory of photon interaction

iv. describe the relativistic quantum phenomena and account for electron spin and electron magnetic moment.

v. AnalyzeFermi and Bose systems using quantum field theory

Unit I: Approximation methods for stationary states

Perturbation theory for discrete levels: Non-Degenerate and Degenerate case - Stark Effect - Two electron Atoms; The variational method: Upper bound on ground state energy - Application to excited states – The Hydrogen Molecule; The WKB Approximation: The Bohr-Sommerfeld quantum condition

Unit II: Evolution with Time

Exact Formal Solutions: Propagators – Relation of Retarded propagator to the Green's function; Perturbation Theory for time evolution problems: Perturbative solution for transition amplitude–Selection Rule - First order transitions – Fermi's Golden rule – Harmonic perturbations – Interaction of an Atom with EM Radiation – The Dipole Approximation – The Einstein's coefficients.

Unit III:Alternative Pictures of Time Evolution

The Schrodinger Picture – The Heisenberg Picture – Matrix Mechanics - The Simple Harmonic Oscillator - Electromagnetic wave as Harmonic Oscillator: Photons – Atom Interacting with Quantized Radiation: Spontaneous Emission – The Interaction Picture – Time Evolution of Ensembles: Density Matrix.

Unit IV: Relativistic Wave Equations

The Klein-Gordon Equation – Plane wave solutions - Interaction with Electromagnetic Fields: Hydrogen-like Atom; The Dirac Equation: Dirac's Relativistic Hamiltonian – Dirac Matrices – Plane wave solutions and Energy Spectrum - The Spin of the Dirac Particle –Spin Magnetic Moment – The Spin orbit Energy.

Unit V: Introduction to Quantum Field Theory

Lagrange's Classical Field Equation – Quantization of the field: Schrodinger Field–Commutation Algebra for Bosons & Fermions-Relativistic fields: Klein-Gordon field- Dirac field - Quantization of EM field.

Text Books:

1. P. M. Mathews & K. Venkatesan, *A Text Book of Quantum Mechanics*, 2nd Ed., Tata McGraw Hill, New Delhi (2013)
2. G. Aruldhas, *Quantum Mechanics*, 2nd Ed., PHI Learning Private limited, New Delhi (2018)

PGP/PSP 5440 MATRIX, FOURIER AND NON LINEAR OPTICS 4hrs/ 4 Cr

This course enables the students to the use of matrix methods and Fourier and Non-linear techniques in optics. Effectively, this is an applied mathematics course, taught with a systems flavor, for students interested in optics.

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

i. apply matrix methods in optics.
ii. describe the characteristics of two dimensional Fourier transform and explain the analysis of linear optical systems.
iii. explain the theory of construction and reproduction of holograms and its applications
iv. elucidate the propagation of light in anisotropic media and electro-optic effect
v. discuss acousto-optic effect and non-linear phenomena in crystals

Unit I: Matrix Methods in Optics

Paraxial Optics: Ray transfer matrices – Translation and refraction matrix – Derivation of properties of a system from its matrix – Experimental determination of the matrix elements of an optical system. Polarization Optics: Jones Matrices – Experimental determination of the elements of a Jones matrix or a Maxwell Column.

Unit II: Fourier Optics

Fourier analysis in two dimensions – Scalar diffraction theory – Integral theorem of Helmholtz and Kirchhoff – Kirchhoff formulation of diffraction by a planar screen – Rayleigh-Sommerfeld formulation of diffraction – Comparison of Kirchoff and Rayleigh-Sommerfeld theories – A thin lens as a phase transformation - Fourier Transforming properties of lenses.

Unit III: Holography

Wavefront Reconstruction – Gabor Hologram – Leith-Upatnieks hologram – Fourier - Transmission and reflection holograms – Recording Materials – Applications: Microscopy, Interferometry, Vibration Analysis, Holographic data storage.

Unit IV: Crystal Optics & Electro Optic Effect

Plane waves in anisotropic media – wave refractive index – ray refractive index – index ellipsoid – index ellipsoid in the presence of external electric field – Electro optic effect: Electro optic effect in KDP.

Unit V: Acousto and Non Linear Optic Effect

Raman – Nath diffraction – Theory of Raman – Nath diffraction – Bragg diffraction – Raman Nathacousto optic modulator – Bragg modulator – Self focusing phenomenon – second harmonic generation

PGP/PSP 5441 **PROJECT – I** **9 hrs/4 cr**

This course enables the Students to have hands-on experience in the design experiments / methodologies and record the process of measurements. He will also learn to correlate with the respective theoretical concepts and draw non-trivial conclusions of the significance of the observations.

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

i. define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data;

ii. identify relevant assumptions or implications; formulate coherent arguments;

iii. act together as a group or a team in the interests of a common cause and work efficiently as a member of a team;

iv. use ICT and demonstrate ability to access, evaluate, and use a variety of relevant information sources;

v. communicate with others using appropriate media; confidently share one's views and express herself/himself.

Students are given the freedom of choosing the topic of the project and approved by the staff supervisor/ guide. It may be theoretical or experimental. After getting approval of the proposed project work within 5 sessions, students are supposed to carry out these projects in the department laboratory. Students shall maintain daily records and present at least two oral progress reports while doing the project. They shall submit the dissertation at the end of the semester. Students are encouraged to have hands-on experience in designing, fabricating, and analyzing the observations using fundamental concepts studied in the course of study.

PHY1101 **Physics Lab for Chemists - I** **2 Hr/ 1 Cr**

This course is introduced to revise the basic measurements and to verify the basic laws of mechanics. The students will familiarize themselves with the theoretical concepts. They are also exposed to hands on training in the lab.

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

i. have hands-on experience in the measurements;
ii. record and process the measurements;
iii. correlate with the respective theoretical concepts; and
iv. explain the significance of the experiment.

S. No.	Experiment
1	Error Analysis (Simple pendulum & UV method)
2	Precise Linear Measurements (Screw Gauge & Vernier Calipers)
3	Usage of Travelling Microscope – Radius of the Capillary tube
4	Spectrometer – Refractive Index
5	Spectrometer – grating
6	Thermal Expansion (Light & Telescope) – Coefficient of thermal expansion
7	Compound Pendulum – 'g' and Radius of Gyration
8	Sonometer – Verification of Laws
9	Newton's Law of Cooling – Specific heat capacity of Liquid
10	Thermocouple – Thermo EMF
11	Measurement of viscosity of liquids at different temperatures
12	Measurement of ultrasonic velocity in binary liquids

PHY1102 Physics Lab for Chemists -II 2 Hr/ 1 Cr

This course imparts skills in measurement, design and experimental procedures. It enables the students to record and process the results to reach non-trivial conclusions and correlate with the respective theoretical concepts. It also helps the students to have hands on experience with modern instrumentation.

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

i. attain hands-on experience in the measurements;
ii. record and process the measurements;
iii. correlate with the respective theoretical concepts; and
iv. draw non-trivial conclusions of the significance of the experiments.

S. No.	Experiment
1	Coefficient of Viscosity – Burette Method
2	Surface Tension – Capillary Rise
3	Young's Modulus - Uniform bending
4	Rigidity Modulus – Torsion Pendulum
5	Melde's Apparatus
6	Specific heat Capacity – Method of mixtures
7	Junction Diode Characteristics
8	Logic gates
9	OP-AMP – Inverting & Non-inverting
10	Lee's Disc – Thermal conductivity
11	Measurement of adiabatic compressibility, free volume using ultrasonic

PHY/PHS 1291 Handling of Tools & Machines 3 Hr/ 2 Cr

This course enables the students to understand the principle, uses and safety handling of hand tools and power tools. It provides hands on experience to handle the tools.

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

i. identify the common tools and select the right tool for a given job;

ii. classify the different types of holding and cleaning tools;
iii. list the safety rules and uses of power tools;
iv. explain the principle, working and uses of machine tools; and
v. discuss about shaper, planer machine and house hold wiring.

Unit 1 **Basic Hand Tools**

Basic hand tools: Wrenches – Screw drivers - Pliers and Wire cutters – Hammers- Spanners – Chisels and Punches – Hand reamers - Files – Ripping bars and Nail pullers – Shovel - Hack saw – basic safety rules for hand tools

Unit 2 **Holding tools and cleaning tools**

Holding tools: Vise – Clamp – Jigs and fixtures - Measuring tools: Rulers – Levels – Plumb bob - spirit level - Cleaning tools – Scrapers – Brushes – Probe and pick up tools

Unit 3 **Power Tools and Equipments**

Power tools and Equipment:Pneumatic tools: Air wrenches – Air hammer – Blow gun - Hydraulic tools: Floor Jack – hydraulic engine crane – Tire changer – Jack stand – Steam cleaner and high pressure washer – Basic safety rules for power tools

Unit 4 **Machine Tools I**

Machine tools: Principle, working, types and uses of drilling machine, Lathe, Milling machine, Grinding machine

Unit 5 Machine Tools II

Principle and working of coil winding machine, Shaper machine and Planer machine - House hold wiring and plumbing

Text book

1. C. Elanchezhian and M. Vijayan, *Machine Tools*, Anuradha Publishers, 2005.

PHY/PHS1292 **Physics of Music** **3 Hr/ 2 Cr**

The objective of this course is to understand and appreciate the nature and production of musical sound associated with musical instruments, in terms of basic physical principles. A physical understanding of sound will enable to make meaningful comparisons among music and toappreciate how the characteristics of a sound depend on the way it is created, designed andplayed.

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

i. explain the sound terminology and usage in music;

ii. illustrate the basic physics of music production;
iii. analyze the quality of sound;
iv. demonstrate the working of certain sound producing instruments; and
v. discuss the acoustics of buildings.

Unit 1 **Sound terminology**
Introduction- Difference between Noise (sound) and music. Units and basic definitions - Frequency-Period-Pitches - Musical Notes, Chords, and Scales

Unit 2 **Physics of music production**
Pythagorean scale –construction. Circle of fifths-Musical Intervals, major and minor notes with frequency. Dissonance, Beats- Logarithmic scales

Unit 3 **Quality of sound**
Combinations of Modes – Superposition - Overtones, Harmonics, Complex Tones. Spectra - Pitch perception - simple mechanics and periodic motion. Chladni patterns - Strings standing waves and harmonics - Sound spectrum - Decibels - Resonance – dissonance - Quality factor

Unit 4 **Some Sound producing instruments**
Helmholtz resonator, Vibrating Strings, air columns.Flute acoustics- construction theory - hole position calculation& making a flute with PVC pipe

Unit 5 **Room Acoustics**
Reverberation time - Sabine's Formula (Derivation not required), - Reflection/Absorption-Auditoriums vs. Recording Studios-Corner Reflectors-acoustic diffusers

Text book

1. Frank S. Crawford Jr., *Waves: Berkeley Physics course Vol-3*, McGraw Hill, International Editions, New Delhi (2011).

PHY/PHS 1294 Photography and Digital Editing 3 Hr/ 2 Cr

This course is intended to utilize the unique and unlimited power of Digital Photography and to become proficient at the technical aspect of photographing with a digital camera. They will be working with those images in post processing including digital editing, saving, sizing, and posting of those images.

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

i. identify different cameras and their potential uses from early days to modern day photography;
ii. discuss the fundamentals of digital photography of lenses focus modes;

describe the digital fundamentals of optics of lenses and its compositions and file formats

iii. use various digital editing tools and techniques;

iv. apply software's basics tools for digital editing;

Unit I: Basics of Photography

Camera - Obscura, Pin hole camera, Different types of camera, Dark room, dark room accessories, Developer, Fixer, Printing machine, Developing film and paper.

Unit II:Digital Photography fundamentals-I

Lenses, Light and Magnification, The power of lenses, Brightness and f-ratios, Magnification and Field of View, Aperture and stops, Shutter speed, ISO, Exposure triangle, Focus modes,

Unit III: Digital Photography fundamentals-II

Lenses and optics, Light, Flash, Composition , Framing and Layering , Landscapes, Wild life, People and Relationships, Post processing and workflow, white balance, File formats.

Unit IV:Digital Editing-I

Basic tools and techniques, images and graphic design, to open images from multiple sources, panels and menus, work with layers, masking, combine effects, other nondestructive edits ,

Unit V: Digital Editing-II

Cropping and straightening images, adjusting the luminance, correcting color, retouching and healing. Sharpening images, Preparing for print and web use.

References

1. Bruce Barnbaum,*The Art of Photography*.
2. Scott Kelby, *The Digital Photography*, 2008.
3. Scott Kelby,*The Photoshop CS Book for Digital Photographers*, 2003.

PHY1381 Physics for Chemists - I 3 Hr/ 3 Cr

This course will enable the students to understand the laws of thermodynamics, atomic and molecular spectroscopy and the nature of light.

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

i. describe the concept of temperature and molecular properties of gases;

ii. discuss the applications of first and second law of thermodynamics;

iii. elucidate the working principle of LASER and the basics of molecular spectroscopy;

iv. explain the image formation in lenses and mirrors; and

v. describe interference, diffraction and polarization of light.

Unit 1 **Temperature & Molecular properties of gases**

Molecular properties of gases – The atomic nature of matter – A molecular view of pressure – Mean free path – Distribution of molecular speeds and molecular energies – Temperature and thermal equilibrium

Unit 2 **Heat & Thermodynamics**

Heat – First law of thermodynamics – Heat capacity and Specific heat – Heat capacity of an ideal gas – Applications of first law – Entropy – Second law of thermodynamics – Performance of engines and refrigerators – Efficiencies of real engines

Unit 3 **LASERs and Spectroscopy**

Nuclear atom – Electron orbits – Atomic Spectra – Bohr atom – Energy levels and Spectra –Atomic Excitation – Laser – Ruby laser – Helium Neon laser – Carbon dioxide laser - Molecules – Molecular bond – The H_2^+ molecular ion - The hydrogen molecule - Complex molecules – Rotational energy levels – Vibrational energy levels – Electronic spectra of molecules

Unit 4 **Light & Ray Optics**

Electromagnetic spectrum – Reflection and refraction of light waves – Image formation by mirrors and lenses – plane mirrors – spherical mirrors – optical instruments

Unit 5 **Physical Optics**

Interference – Double slit interference – Interference from thin films – Diffraction – Single slit diffraction – Diffraction grating – Dispersion and resolving power – X-ray diffraction – Polarization – Polarization by reflection – Double refraction – Circular polarization.

Text books

1. Resnick, Halliday, Krane, *Physics – Volume I*, John Wiley and Sons, Fifth Edition (2004).
2. Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw Hill, New Delhi, (2008).

PHY/PHS 1373 **Physics Lab - I 3 Hr/ 3 Cr**

This course is introduced to revise the basic measurements and to verify the basic laws of mechanics. The students will familiarize themselves with the theoretical concepts. They are also exposed to hands on training in the lab.

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

i. experience hands-on training in the measurements;
ii. perform data and error analysis;
iii. relate with the respective theoretical concepts;
iv. record and process the measurements; and
v. arrive at conclusionsfor significance of the experiments.

S. No.	Experiment
1	Error Analysis (Simple pendulum & UV method)
2	Precise Linear Measurements (Screw Gauge &Vernier Calipers)
3	Usage of Travelling Microscope – Radius of the Capillary tube
4	Rigidity Modulus – Torsion Pendulum
5	Spectrometer – Refractive Index
6	Thermal Expansion (Light & Telescope) –Coefficient of Thermal Expansion
7	Compound Pendulum – 'g' and Radius of gyration
8	Sonometer – Verification of Laws
9	Newton's Law of Cooling – Specific heat capacity of liquid
10	Moment of Inertia – Fly Wheel
11	Measurement of viscosity of liquids at different temperatures
12	Measurement of ultrasonic velocity in binary liquids

PHY/PHS1374 Physics Lab - II 3 Hr/ 3 Cr

This course is introduced to revise the basic measurements and to verify the basic laws of mechanics. The students will familiarize themselves with the theoretical concepts. They are also exposed to hands on training in the lab.

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

i. experience hands-on training in the measurements;
ii. perform data and error analysis;
iii. relate with the respective theoretical concepts;
iv. record and process the measurements; and
v. arrive at conclusions for significance of the experiments.

S. No.	Experiment
1	Coefficient of Viscosity – Poiseuille's Method
2	Surface Tension – Capillary Rise
3	Young's Modulus - Uniform bending
4	Usage of Multimeter& CRO
5	Melde's Apparatus
6	Specific heat Capacity – Method of mixtures
7	Potentiometer – Measurement of resistance
8	Spectrometer – Grating
9	Spectrometer – (i-d) Curve
10	Lloyd's mirror
11	Measurement of adiabatic compressibility, free volume using ultrasonic interferometer
12	Verification of Lorentz-Lorentz mixing rule for binary liquids for the calculation of refractive indices

PHY1381 Physics for Chemists - I 3 Hr/ 3 Cr

This course will enable the students to understand the laws of thermodynamics, atomic and molecular spectroscopy and the nature of light.

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

vi. describe the concept of temperature and molecular properties of gases;
vii. discuss the applications of first and second law of thermodynamics;
viii. elucidate the working principle of LASER and the basics of molecular spectroscopy;
ix. explain the image formation in lenses and mirrors; and
x. describe interference, diffraction and polarization of light.

Unit 1 **Temperature & Molecular properties of gases**

Molecular properties of gases – The atomic nature of matter – A molecular view of pressure – Mean free path – Distribution of molecular speeds and molecular energies – Temperature and thermal equilibrium

Unit 2 **Heat & Thermodynamics**

Heat – First law of thermodynamics – Heat capacity and Specific heat – Heat capacity of an ideal gas – Applications of first law – Entropy – Second law of thermodynamics – Performance of engines and refrigerators – Efficiencies of real engines

Unit 3 **LASERs and Spectroscopy**

Nuclear atom – Electron orbits – Atomic Spectra – Bohr atom – Energy levels and Spectra –Atomic Excitation – Laser – Ruby laser – Helium Neon laser – Carbon dioxide laser - Molecules – Molecular bond – The H_2^+ molecular ion - The hydrogen molecule - Complex molecules – Rotational energy levels – Vibrational energy levels – Electronic spectra of molecules

Unit 4 **Light & Ray Optics**

Electromagnetic spectrum – Reflection and refraction of light waves – Image formation by mirrors and lenses – plane mirrors – spherical mirrors – optical instruments

Unit 5 **Physical Optics**

Interference – Double slit interference – Interference from thin films – Diffraction – Single slit diffraction – Diffraction grating – Dispersion and resolving power – X-ray diffraction – Polarization – Polarization by reflection – Double refraction – Circular polarization.

Text books

3. Resnick, Halliday, Krane, *Physics – Volume I*, John Wiley and Sons, Fifth Edition (2004).
4. Arthur Beiser, *Concepts of Modern Physics*, Tata McGraw Hill, New Delhi, (2008).

PHY1382 Physics for Chemists - II 3 Hr/ 3 Cr

This course will enable the students to understand the basic laws of electrostatics, magnetostatics and the basic principles of electronics.

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

i. describe the laws governing electric field and evaluate the electric field for various charge distribution;
ii. discuss the electric potential in different configurations;
iii. describe the laws governing magnetic field and classify the magnetic materials;
iv. explain the operation of electronic devices and their simple applications; and
v. design logic circuits using gates.

Unit 1 Electric charge and Electric field

Electric charge - Coulomb's law – Continuous Charge distributions – Electric field – Electric field lines - Dipole in an electric field - Flux – Gauss law – Applications of Gauss law

Unit2 Electric potential and Capacitors

Electric potential – Electric potential of continuous charge distributions – Capacitors – Parallel plate capacitor – Capacitor with dielectrics – Electric current – resistors in series and parallel

Unit 3 Magnetostatics

Magnetic field –Magnetic force on a moving charge – Hall effect – Biot- Savart law – Magnetic field due to a solenoid – Ampere's law – Applications of Ampere's law – Faraday's law of induction – Lenz's law – Magnetization – Magnetic materials

Unit 4 Analog Electronics

Semiconductor – Intrinsic and Extrinsic, n and p – type – PN junction diode – Rectifier Transistor configurations – CE amplifier and its uses – Oscillator – Hartley oscillator – Colpitt's oscillator - Introduction to op-amps – characteristics – Unity follower – Adder – Subtractor – Integrator and Differentiator

Unit 5 Digital Electronics

Number Systems - Logic gates – Boolean algebra – NAND and NOR as universal gates – Sequential logic circuits – Half and full adder

Text books

2. Resnick, Halliday,Krane, *Physics – Volume II*, John Wiley and Sons, Fifth Edition (2002).

B.L. Theraja, *Basic Electronics*, S. Chand and Company, New Delhi (1989).

PHY/PHS 1551 Physics of Motion 5 Hr/ 5 Cr

The aim of this course is to enable the students to have a thorough understanding of the basic concepts of physics of linear, rotational, and oscillatory motions in different dimensions and wave propagation in elastic media.

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

i. describe two and three dimensional motions and conservation of momentum in a system of particles;
ii. apply law of conservation angular momentum appropriately in rigid body rotations, relate the rotational and translational parameters based on rotational kinematic;
iii. explain the rotational kinematics and evaluate the inter-relationship between work and energy;
iv. explain the concept of fluid dynamics and its applications;
v. describe SHM and list the wave types and its properties; and analyze the properties of sound waves and Doppler Effect.

Unit 1 **Linear Motion**

Force and Newton's laws - weight and mass - motion in three dimensions - projectile motion, uniform circular motion - types of forces. Momentum - conservation of momentum, two-body collisions, one-dimensional collisions in centre of mass frame of reference, two particle systems, many particle systems, conservation of momentum in a system of particles

Unit 2 **Rotational Motion**

Rotational kinematics – variables - rotation with constant acceleration - relationship with linear and angular variables – torque - angular momentum of particles - conservation of angular momentum - spinning top - Work and energy, power, kinetic energy and work-energy theorem and proof

Unit 3 **Fluid Dynamics**

Pressure and density in a fluid, variation of pressure in atmosphere, Pascals and Archimedes' principle, measurement of pressure, surface tension, fluid flow, equation of continuity, Bernoulli's equation and its applications, Venturi meter, Pitot tube

Unit 4 **Oscillations**

Simple harmonic oscillations, Energy of simple harmonic motion, torsional oscillator, simple pendulum, physical pendulum, Waves and its types, traveling waves, sinusoidal waves, speed of a wave, Energy of a wave, principle of superposition, interference, standing waves and resonance

Unit 5 **Wave propagation in Elastic Media**

Sound waves and its properties, travelling sound waves, speed of sound, power and intensity, interference, vibrating systems, beats, Doppler Effect

1. Halliday, Resnick and Krane, *Physics Vol.I*, Vthedition, Wiley India, (2002)

PHY 1552 GEOMETRICAL & PHYSICAL OPTICS 5 Credits 5 hrs/wk

Course Objectives:

Enable the students

- to learn and understand the Properties of lenses and principles of image formation;
- to comprehend the physics of aberrations and Optical instruments;
- to understand the interference phenomena of light;
- to comprehend and apply the diffraction of light;
- to learn and understand the effect of polarization

Unit – I Spherical Surfaces and Lenses

Properties of Light – Speed of Light – Laws of Reflection and Refraction – Graphical Construction for Refraction – Color Dispersion – Critical Angle and Total Reflection – Refraction by a Prism – Minimum Deviation – Focal Point and Focal Length – Image Formation – Conjugate Points and Planes – Gaussian Formula (Derivation) - Lateral Magnification – Virtual Images – Lens Makers' Formula – Thin Lens Combination – Thin Lenses in Contact – Thick Lens Formula – Nodal Point – Cardinal Points.

Unit – II Aberrations and Optical Instruments

Field Stop and Aperture Stop – Entrance and Exit Pupils – Ray Tracing Formula (Calculations) - First and Second Theory of Aberrations – Spherical Aberration – Coma – Astigmatism – Chromatic Aberration – Human Eye – Cameras and Photographic objectives –

Speed of Lenses – Magnifiers – Microscopes – Astronomical Telescopes – Huygens and Ramsden Eyepiece – Binoculars.

Unit – III Interference

Huygens' Principle – Young's Experiment – Interference from Double Source – Fresnel's Biprism – Lloyd's Mirror – Michelson Interferometer – Circular Fringes – Localized Fringes – White Light Fringes – Visibility of Fringes – Reflection from Plane Parallel Film – Newton's Rings – Fabry-Perot Interferometer – Brewster's Fringes.

Unit – IV Diffraction

Fresnel and Fraunhofer Diffraction – Diffraction by Single Slit – Rectangular and Circular Aperture – Resolving Power of Telescope and Microscope – Double Slit – Distinction Between Interference and Diffraction – Positions of the Maxima and Minima – Michelson's Stellar Interferometer – Diffraction Grating – Spectra by Grating – Resolving Power – Fresnel's Half-Period Zones – Zone Plate.

Unit – V Polarization

Polarization – Polarization by Reflection – Vibrations in Light - Polarization Angle and Brewster's Law – Law of Malus – Polarization by Dichromic Crystals – Double Refraction – Optic Axis – Nicol Prism – Blue Sky and Red Sunset - Polarization by Scattering – Elliptically and Circular Polarized Light – Quarter and Half-Wave Plates – Babinet Compensator – Analysis of Polarized Light.

Text Book:

F. A. Jenkins and **H. White**, Fundamentals of Optics, 4th Edition, McGraw Hill, International Editions, New Delhi (2011).
(Unit I:Ch 1 to 5; Unit II: Ch 7 to 10; Unit III: Ch 13 and 14; Unit IV: Ch 15 to 18; Unit V: Ch 24 and 27)

PHY/PHS 1557 Energy Physics 5 Hr/5 Cr

The aim of this course is to enable the Students to know the abundance of solar radiation and to understand the principle of conversion solar energy into thermal conversion and electrical energy. Students get exposed to various types of non-conventional energy sources and know the methods of energy storage.

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

i. identify the renewable and non-renewable energy sources and describe their applications;
ii. classify the types of solar energy collectors and cells;
iii. describe the various thermal and electrical applications;
iv. identify various non-conventional energy sources and their uses; and
v. devise methods for energy storage systems.

Unit 1 **Energy Sources, Solar Radiations and its Measurements**

Energy sources- Resources and availability - Energy consumption - renewable and nonrenewable energy systems - fossil fuel availability - merits and demerits – Applications - solar radiation geometry - solar constant - solar radiation measurements - Solar radiation data

Unit 2 **Solar Energy Collectors and Cells**

Flat plate collectors- working principles – collector efficiency and thermal losses- Evacuated tubular collectors- types of evacuated tube collector – working principle – thermal characteristics – concentrating collector –

advantage and disadvantage over flat plate collector – Solar cell – working principle – types of solar cell – efficiency of solar cell(No derivation)

Unit 3 **Solar Electrical and Thermal Applications**

Solar electrical applications – lighting applications – other electrical applications - Solar water heating systems - Solar dryers - Solar cooker - Solar still - Solar refrigeration - Solar thermal electric conversion (Low, Medium, High)

Unit4 **Non - Conventional Energy Sources**

Wind energy - type of wind mills - Total, Maximum power & forces on the blades - advantage and disadvantage - Open & Closed OTEC system - energy & power from waves single pool and modulated single pool tidal systems - Geothermal energy – vapour and liquid dominated systems - Advantages and disadvantages of Geothermal energy

Unit 5 **Energy Storage and Energy Conservation**

Solar energy storage – thermal storage electrical storage – chemical storage – mechanical storage – storage of energy in solar pond and its extraction – principle of energy conservation – energy and their conservation.

Text Books

1. S.P. Sukhatme, *Solar energy principles of thermal collection and storage*, II Ed. McGraw Hill Publications, New Delhi (2004).

G. D. Rai,*Solar Energy Utilizations*, Khanna Publication (1996

PHY/PHS 1558 **Electrodynamics** **5 Hr/ 5 Cr**

This course apprises the students regarding the concepts of electrostatics, electrodynamics and Maxwell equations and enables their use in various situations.

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

i. explain the concept of Coulomb's and Gauss' laws and their applications;
ii. diagnose the electric circuits;
iii. compare and relate electricity and magnetism;
iv. interpret the concepts of magnetic induction and classify magnetic materials; and
v. construct the basic equations of electro-magnetism and describe the propagation of electromagnetic waves.

Unit 1 **Electrostatics**

Electric charge – Coulomb's law – charge and matter – electric field – lines of force – calculation of electric field due to a dipole, ring of charge and line of charge – a point charge, a dipole in an electric field – Gauss' law and applications

– electric potential - potential due to a point charge, a dipole, a group of charges – electric potential energy - calculations of electric field and electric potential

Unit 2 **Electric Circuits**

Capacitors and dielectrics – parallel plate capacitor with dielectric – dielectrics and Gauss's law – three electric vectors – energy storage in an electric field -

Current and current density – resistance, resistivity, and conductivity – Ohm's law - energy transfers in an electric circuits – electromotive force – calculating current – potential differences – single-loop and multi-loop circuits – potentiometer – RC circuits

Unit 3 **Electrodynamics**
Magnetic field – Magnetic induction (B) – magnetic force on a current – torque on a current loop – Hall effect – circulating charges – cyclotron – Thomson experiment – Ampere's law – B near a long wire applications of Ampere's law – magnetic lines of induction – two parallel currents -B for a solenoid – Biot-Savart law

Unit 4 **Magnetic Induction & Magnetic Properties of Matter**
Electromagnetic induction – motional emf - Faraday's law of induction – Lenz's law – time-varying magnetic fields - inductance – energy in magnetic fields – Betatron – induction and relative motion – magnetic properties of matter - magnetic dipoles – paramagnetism - diamagnetism – ferromagnetism – nuclear magnetism – three magnetic vectors

Unit 5 **Electromagnetic waves**
Electromagnetic oscillations – LC oscillations – analogy to simple harmonic motion - forced oscillations and resonance - electromagnetic cavity oscillator – displacement current – Maxwell's equations – Poynting vector - Maxwell's equations and cavity oscillations – transmission lines – coaxial cable – waveguide – radiation – traveling waves and Maxwell's equations

Textbook
1. Halliday, Resnick and Krane, *Physics Vol II*, V^{th} edition, John Wiley (2002).

Reference
2. David J. Griffiths, *Introduction to Electrodynamics*, Prentice-Hall of India, New Delhi (2003).

PHY2101 Physics Lab for Mathematics - I 2 Hr/ 1 Cr

This course imparts skills in measurement, design and experimental procedures. It enables the students to record and process the results to reach non-trivial conclusions and correlate with the respective theoretical concepts.. It also helps the students to have hands on experience with modern instrumentation.

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

i. attain hands-on experience in the measurements;
ii. record and process the measurements;
iii. correlate with the respective theoretical concepts; and
iv. draw non-trivial conclusions of the significance of the experiments.

S. No.	Experiment
1	Error Analysis (Simple pendulum / UV method)
2	Precise Linear Measurements (Screw Gauge & Vernier Calipers)
3	Usage of Travelling Microscope – Radius of the Capillary tube
4	Spectrometer – Refractive Index
5	Spectrometer – grating
6	Thermal Expansion (Light & Telescope) – Coefficient of thermal expansion
7	Compound Pendulum – 'g' and Radius of Gyration
8	Sonometer – Verification of Laws
9	Newton's Law of Cooling – Specific heat capacity of Liquid
10	Plane grating – using CD

PHY2102 Physics Lab forMathematics - II 2 Hr/ 1 Cr

This course imparts skills in measurement, design and experimental procedures. It enables the students to record and process the results to reach non-trivial conclusions and correlate with the respective theoretical concepts. It also helps the students to have hands on experience with modern instrumentation.

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

- i. attain hands-on experience in the measurements;
- ii. record and process the measurements;
- iii. correlate with the respective theoretical concepts;
- iv. apply the analytical techniques and graphical analysis to the experimental data; and
- v. draw non-trivial conclusions of the significance of the experiments.

S. No.	Experiment
1	Coefficient of Viscosity – Burette Method
2	Surface Tension – Capillary Rise
3	Young's Modulus - Uniform bending
4	Rigidity Modulus – Torsion Pendulum
5	Melde's Apparatus
6	Specific heat Capacity – Method of mixtures
7	Junction Diode Characteristics
8	Logic gates – universal gates
9	OP-AMP – Inverting & Non-inverting
10	Lee's Disc – Thermal conductivity

PHY2381 Physics for Mathematics-I 3 Hr/ 3 Cr

This course enables the students to understand the fundamental of Mechanics & energy in a system of particles. It helps to gain knowledge about the properties of gravitation which is one of the fundamental and universal forces of natureThis course also helps them to understand the motion under free, damped and forced conditions & propagation of mechanical waves in elastic media.

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

i. describe linear and angular motion in 1D and 2D systems;
ii. evaluate the energy in a system of particles;
iii. explain the mechanics of particles under gravitation;
iv. distinguish harmonic motion under free, damped and forced conditions; and
v. ascertain the propagation of mechanical waves in elastic media.

Unit 1 Motion in 1D and 2D systems

Position, Velocity and Acceleration, One dimensional kinematics, Motion with constant acceleration, Free falling bodies, Projectile motion, Linear momentum, Impulse, Force, Conservation of momentum, Two-body collision, Rotational variable, Rotation with constant acceleration, Relationship between linear and angular variables, Angular momentum of a particle, System of particles, Torque, Conservation of angular momentum

Unit 2 Energy

Work done on a system by external forces, Internal energy in a system of particle, Frictional work, Conservation of energy in a system of particles

Unit 3 Gravitation

Newton's law of universal gravitation, Gravitational constant, Gravitation near the earth's surface, The two shell theorem, Gravitational potential energy, Motions of planets and satellites

Unit 4 Oscillations

Simple harmonic oscillator, Simple harmonic motion, Energy in simple harmonic motion, Applications of simple harmonic motion, Damped harmonic motion, Forced oscillations

Unit 5 Wave propagation in elastic media

Mechanical waves, Types of waves, Travelling waves, Sinusoidal waves, The wave equation, Interference of waves, Standing waves and resonance, Properties of sound waves, Travelling sound waves, Speed, power and intensity of sound waves, Interference of sound waves, Standing longitudinal waves, Vibrating systems and sources of sound, Beats, The Doppler effect

Text Book

1. David Halliday, Robert Resnick and Kenneth S Krane, *Physics-Vol I,* 5th Edition, John Wiley & Sons, Inc 2007.

PHY2382 Physics for Mathematics-II 3 Hr/ 3 Cr

This course intends to provide knowledge on Electrostatics, electric potential in different configurations&laws governing magnetic field and resonance. It also deals with electronic devices and their simple applications and logic circuits.

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

i. explain the basics of Electrostatics;
ii. discuss the electric potential in different configurations;
iii. describe the laws governing magnetic field and resonance;
iv. explain the operation of electronic devices and their simple applications; and
v. design logic circuits using gates.

Unit 1 Electrostatics I

Electric charge, Coulomb's law, Continuous charge distribution, Electric field, Electric field of point charges and of continuous charge distributions, Gauss' law, Applications of Gauss' law

Unit 2 Electrostatics II

Electric potential energy, Potential due to point charges, collection of point charges and an electric dipole, Electric potential of continuous charge distributions, Calculating the field from the potential, Potential of a charged conductor, Capacitance, Capacitors in series and parallel, Energy stored in an electric field, Capacitor with a dielectric

Unit 3 Magnetostatics and resonance circuits

Magnetic force on a moving charge and a current- carrying wire, Torque on a current loop, Magnetic field due to a moving charge, Magnetic field of a current and a solenoid, Ampere's law, Faraday's law of induction, Lenz's law, induction and energy transfers, Self inductance, LR circuit, LCR circuit

Unit 4 Analog electronics

Intrinsic and Extrinsic semiconductor, Formation and V-I characteristics of PN junction diode, Zener diode and LED, Transistors, Various configurations of transistor, CE transistor amplifier, Operational amplifier and its characteristics, inverting and non-inverting amplifier, adder, subtractor, differentiator, integrator

Unit 5 Digital electronics

Logic gate – Universal logic gates - Half adder, Full adder, Half subtractor, Full subtractor - Decoders: 1-of-16 Decoder, BCD-to-decimal Decoders, Seven-segment Decoders - Flip-flops: RS Flip-flops, D and JK Flip-flops, Shift Registers - Synchronous and Asynchronous Counters

PHY/PHS 2475 Mathematical Physics 4 Hr/ 4 Cr

This course enables the students to gain knowledge in differential equations which are essential to solve advanced problems in physics, to understand special functions in mathematical methods and too learn the essentials of matrices.

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

- -

i. formulate and solve the partial differential equations in physics;
ii. describe the special polynomials and their properties;
iii. apply special functions to describe physical systems;
iv. classify the types of matrices and determine Eigenvalues and Eigenvectors; and
v. explain the Fourier and Laplace transforms and their uses.

Unit 1 **Differential Equations**
Partial differential equations in Physics – method of separation of variables - separation of Helmholtz equation in Cartesian, spherical polar coordinates – Laplace's equation in various coordinate systems

Unit 2 **Special Functions – I**
Bessel functions – spherical Bessel function – Legendre polynomials – Hermite polynomials – Lagurre polynomials – recurrence relations – orthonormality relations

Unit 3 **Special Functions – II**
Beta, gamma , Dirac Delta, Green's, Airy Functions – Green function for one dimensional problem - Eigen function expansion of Green's function

Unit 4 **Matrices**
Orthogonal, Unitary and Hermitian matrices and its properties – Eigen value and Eigen vector of a matrix – Matrix Diagonalization – Matrix representation of Linear operators – Special matrices in Physics

Unit 5 **Integral Transforms**
Fourier Integral – Fourier Transform – Convolution theorem – Applications of Fourier Transform – Laplace Transform – Laplace Transform of Derivatives - Convolution theorem – Applications of Laplace transforms

Text Book
1. K. Chattopadhyay, *Mathematical Physics*, New Age International, 2013.

References
1. Charlie Harper, *Introduction to Mathematical Physics*, PHI Learning Pvt. Ltd., 2012.
2. Arfken, Weber, and Harris, *Mathematical Methods for Physicists*, Elsevier India Pvt. Ltd., 2013.

PHY/PHS 2476 **Classical Mechanics** **4 Hr/ 4 Cr**

This course is intended to review the concepts of Newtonian mechanics. The students will be introduced the formalisms of Lagrangian and Hamilton. They are exposed to small amplitude oscillations.
At the end of the course, students will be able to
i. classify the types of constraints and describe the constrained motion;
ii. formulate the Lagrange's equations of motion and describe Hamilton's principle;

iii. articulate the Kepler's laws and arrive at equations of motion using Hamilton's equations;

iv. explain Poisson and Lagrange's brackets and describe rigid body dynamics; and

v. apply the theory of small oscillations and find normal modes of coupled oscillations.

Unit 1 **Review of Newtonian Mechanics and Constrained Motion**

Frames of reference - inertial and non-inertial frames - Mechanics of a particle - Motion under constant, time- dependent, velocity dependent forces. Motion of charged particle in Magnetic field - System of particles: centre of mass – conservation of linear and angular momentum - kinetic energy for a system of particles - Energy conservation of system of particles. Constraints - Holonomic – Non-holonomic constraints – Scleronomous and Rheonomous constraints

Unit 2 **Lagrangian Formulation and Variational Principle**

Generalized coordinates - degrees of freedom - configuration of space - Lagrange's equations - Kinetic energy in generalized co-ordinates - generalized momentum - first integrals of motion - and cyclic coordinates - velocity dependent potential - dissipative force - Newtonian and Lagrangian formalisms. Variational Principle: Hamilton's principle-deduction of Hamilton's principle-Lagrange's equation from Hamilton's principle

Unit 3 **Central force Motion and Hamiltonian Formalism**

Reduction to one-body problem-general properties of central force motion-effective potential-classification of orbits-Motion in a central force field- inverse square law of force-Kepler's laws- laws of gravitation from Kepler- Scattering in a central force field. Hamiltonian formalism: The Hamiltonian of system-Hamilton's equations of motion-Hamilton's equations from variational principle-Integrals of Hamilton's equations

Unit 4 **Canonical Transformations, Poisson Brackets and Rotational motion** Canonical transformations-Poisson brackets-Poisson bracket and integrals of motion-the canonical invariance of Poisson bracket-Lagrange's brackets.

Motion of rigid bodies: Angular momentum-kinetic energy-Inertia tensor-principal axes- Euler's angles-Infinitesimal rotations- rate of change of a vector - Coriolis forces- Euler's Equations of motion-Force free motion of a symmetrical top

Unit 5 **Small oscillations**

Theory of small oscillations: Equilibrium and potential energy-Theory of small oscillations- normal modes-two coupled pendulum-longitudinal vibrations of CO_2 molecule

Text Book

1. G.Aruldhas, *Classical Mechanics*, PHI Learning Private Limited, 2013.

PHY/PHS 2477 **Modern Optics** **Hr/ 4 Cr**

This Course is to understand the fundamentals of propagation of light waves. Students familiarize with the working principles of LASERS. They gain knowledge about Fourier Optics and Crystal

Optics. Also this course applies the theories in optics to fiber optics communication.

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

i. calculate the intensity change and phase differences of light waves upon reflection from dielectric and metallic surfaces;
ii. explain the working of lasers and its applications;
iii. describe the characteristics of two dimensional Fourier transform and explain the diffraction effects in optical systems;
iv. elucidate the concepts of Crystal Optics; and
v. use the theories in optics to explain fiber optics communication.

Unit 1 **Light Wave**

Reflection from Dielectrics – Intensities of the Transmitted Light - Internal Reflection – Phase Change on Reflection – Metallic Reflection – Optical Constants of Metals

Unit 2 **Laser**

Einstein Coefficients – Light Amplification – Threshold Condition – Laser Rate equation (Three Level Only) – Variation of Laser Power around Threshold – Line Broadening Mechanisms (no derivation) – types Lasers

Unit 3 **Fourier Optics**

Fresnel and Fraunhofer Diffraction: Fraunhofer Diffraction – Diffraction Formula – Rectangular Aperture - Fresnel Diffraction – Diffraction Integral – Diffraction of a Gaussian Beam - Fourier Transform and Some of its Important Properties – holography

Unit 4 **Crystal Optics**

Double Refraction – Wave Surface of Uniaxial Crystals – Propagation of Plane Wave in Uniaxial crystals – Elliptically and Circularly Polarized Light – Quarter and Half Wave Plates – Babinet Compensator

Unit 5 **Fiber Optics**

Optical Fiber – Numerical Aperture – Multimode Graded Index Fibers – Single Mode Fibers – Pulse Dispersion in Step Index Fiber - Fiber Optic Communication Systems

Text Book

1. Jenkins and White, *Fundamentals of Optics*, 4th Edition, McGraw Hill, International Editions, New Delhi (2011).
2. Ghatak A and K Thyagarajan, *Optical Electronics*, Cambridge University Press, Cambridge (1988).

PHY/PHS2480 Quantum Mechanics and Relativity 4 Hr/ 4 Cr

This course enable the Students to understand the concepts of Special theory of relativity, the inadequacies of classical physics, the fundamentals of quantum mechanics, and to learn the skills of quantum mechanics and its applications to free state and bound states.

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

i. explain the special theory of relativity and its consequences;
ii. discuss and establish the dual nature of matter;
iii. describe the wave mechanical concepts of quantum systems;
iv. elucidate the basic formalism of quantum mechanics; and
v. devise and explain exactly solvable quantum systems.

Unit 1 **Relativity**
Special relativity - Lorentz transformation – Time Dilation – Doppler effect – Length Contraction – Twin paradox – Relativistic momentum – Mass and Energy – Energy and momentum

Unit 2 **Dual Nature**
Blackbody radiation – Photoelectric effect – Light – Compton effect – Pair production – Photons & Gravity – de Broglie waves – Waves of Probability – Particle diffraction

Unit 3 **Wave mechanical concepts**
The Uncertainty principle, The principle of superposition, Wave packet, Time-dependent Schrodinger equation, Interpretation of the wave functions - Ehrenfest's theorem – Time-independent Schrodinger equation – Stationary States – Admissibility conditions on the wave function

Unit 4 **General Formalism of Quantum Mechanics**

Linear vector space, linear operator, Eigenfunctions and Eigenvalues, Hermitian operator, Postulates of Quantum Mechanics, Simultaneous Measurability of observables – General uncertainty relation, Dirac's notation, Equations of motion, Momentum Representation

Unit 5 **Exactly Solvable problems**

Free particle, Step potential, Potential barrier, Infinite potential well, Particle in a box, Finite square well, Linear harmonic oscillator (No derivation), Particle moving in a spherically symmetric potential- Hydrogen atom(No derivation)

Text Book:

1. Arthur Beiser, *Concepts of Modern Physics*, 6th Ed, McGraw Hill (India) Pvt. Ltd., 2009.
2. G.Aruldhas, *Quantum Mechanics,* 2nd Edition, PHI Learning Private limited, 2012.

PHY/PHS 2573 **Analog Electronics** **5 Hr/ 5 Cr**

Enable the Students to understand the characteristics and applications of semiconductor devices and to analyze, verify their functions.

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

i. interpret the basics circuit laws;
ii. characterize the semiconductor devices and circuits;
iii. describe the theoretical modelsof transistor amplifier circuits;
iv. design and explain oscillator circuits; and
v. explain the characteristics of operational amplifier and apply it for constructing amplifiers and oscillators.

Unit 1 **Basic theorems and circuits**

Kirchhoff's Voltage Law, Kirchhoff's Current Law. Constant voltage source and current source and their conversion. Superposition Theorem. Thevenin's Theorem, Norton's Theorem and their conversion. Intrinsic and Extrinsic semiconductors, Energy Band diagram. Fermi level- Forward and reverse bias. Diode equation (no derivation) - regulated power supply and ripple factor - Clippers, clampers. Biased clipper and clamper, voltage multipliers, half wave & full wave rectification- bridge rectifier. Zener diode-voltage regulator, light emitting diodes, Laser diodes

Unit 2 **BJT properties and biasing**

Bipolar Junction Transistors (BJT): Transistor fundamentals -configurations, DC operating point and load line. BJT characteristics - fixed bias, emitter bias potential divider bias. Analysis of above circuits and their design, variation of operating point and its stability. Two–port network. Hybrid Parameters

Unit 3 **Transistor Amplifiers**

Transistors Amplifier: Small Signal common base and common emitter amplifiers : AC equivalent circuit, hybrid model and their use in amplifier design. Multistage amplifiers, frequency response of basic & compound configuration, Power amplifiers: Class A, B, AB, C

Unit 4 **Transistor Oscillators**

Feedback &Oscillator Circuits: Feedback- effect of positive and negative feedback, basic feedback topologies & their properties. Phase shift and Wien's bridge, RC oscillators with theory. Colpitt's and Hartley LC oscillators. Crystal Oscillators

Unit 5 **OP-AMP Characteristics and applications**

Operational Amplifier & FET: Characteristics of Op-Amp - Pin out of IC 741. Differential and Common mode operation. Inverting & Non Inverting Amplifier, Differential amplifier- Summing and difference amplifier. Integrator - differentiator - Comparator Field-Effect Transistors (FET) - JFET- current-voltage characteristics - FET types only- FET amplifier

Text Book(s)

1. Albert Malvino, David Bates ,*Electronic Principles.* 8th Edition,. McGraw-Hill Education. 2015.
2. Floyd, *Electronic devices,* 5th Edition,, Pearson Education, 2001.

References

1. B.L.Theraja,*Basic electronics solid state,*S. Chand Publications, 2006.
2. V.K.Metha&RohitMetha, *Principles of Electronics,* S Chand Publications, 2005.

PHY/PHS 2574 **Digital Electronics** **5 Hr/ 5 Cr**

This course enables students to understand the fundamentals of digital electronics, different number systems and codes used in it. Students gain knowledge about logic gates and Boolean algebra and learn about the combinational and sequential logic systems. This course helps them to understand the function of D/A, A/D converters and various memory devices.

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

i. apply digital logic for designing combinational logic circuits;
ii. explain various number systems and their applications;
iii. describe data processing circuits;
iv. classify and realize various sequential circuits; and
v. elucidate various timing circuits, D/A and A/D conversion techniques and memory devices.

Unit 1 **Digital Logic and Combinational Logic Circuits**

Digital Signals and Logic, Storing and transferring digital information, Basic

Gates and universal logic Gates, Positive and Negative logic, Combinational Logic Circuits: Boolean laws and basic theorems, Sum-of-Products method, Karnaugh map (up to 4 variables), Karnaugh simplification (with don't care conditions), Product-of-Sum method, POS simplification

Unit 2 **Number Systems and Codes**

Binary number system, Decimal-Binary-Octal and Hexadecimal-their representation, Inter-conversion,BCD,Weighted binary codes, ASCII character code, excess-3 code, Gray code and Error detecting and correcting code, Binary to Gray code conversion and vice-versa, Binary addition and subtraction, Unsigned and Sign-magnitude numbers, 2's complement representation, 2's complement arithmetic, Half adder, Full adder, Half subtractor, Full subtractor

Unit 3 **Data Processing Circuits**

Multiplexers, Demultiplexers, Decoders: 1-of-16 Decoder, BCD-to-decimal Decoders, Seven-segment Decoders, Encoders: Decimal to binary, Decimal to BCD, Octal to binary and Priority Encoders, Exclusive -OR Gates, Parity checker, Parity generator, Magnitude comparator, Programmable Array Logic, Programmable Logic Arrays

Unit 4 **Flip-flops, Registers and Counters**

RS Flip-flops, Gated Flip-flops, Edge-triggered RS, D and JK Flip-flops, Flip-flop Timing, JK Master/slave Flip-flops. Shift Registers, Serial in-Serial out, Serial in-Parallel out, Parallel in-Serial out and Parallel in-Parallel out shift registers, Ring Counters, Synchronous and Asynchronous Counters, Mod-3 and mod-6 counters, Decade Counters, Cascaded counters, Synchronous up/down counter

Unit 5 **Timing Circuits, D/A and A/D Conversions**

Schmitt Trigger, Astable, Monostable and Bistablemultivibrators, Basics of digital signal processing, A/D conversion, Simultaneous type A/D converter - Successive approximation type A/D converter, Specifications of D/A converter, Binary-Weighted-input D/A converter, Memory: Basic terms and ideas, Memory addressing, RAMs, ROMs, PROMs and EPROMs

Text Books

1. Donald P Leach, Albert Paul Malvino and GoutamSaha,*Digital Principles and Applications*,6th Edition, The McGraw-Hill Companies 2006.
2. Thomas L Floyd,*Digital Fundamentals*, 8th Edition, Pearson Education 2003.

PHY/PHS 2671 **Physics Lab – III** **6 Hr/ 6 Cr**

The Course is to have hands-on experience in the measurements. Students make known with the record and process the measurements. They correlate with the respective theoretical concepts anddraw non-trivial conclusions of the significance of the experiments.

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

i. get hands-on experience in the measurements;
ii. construct experiments on optics and electricity and illustrate the related theoretical concepts;
iii. compute observed values and compare with the standards;
iv. examine the measurements to draw valid conclusions; and
v. work cooperatively in a small group environment.

Minimum of 16 Experiments should be completed.

S. No.	Experiment
1	Solar Constant – using Lee's Disc
2	Spectrometer – Cauchy's Constants
3	Spectrometer – (i-i') Curve
4	Spectrometer – Dispersive Power
5	Newton's Rings
6	Fresnel's biprism
7	Field along the axis of a circular coil – Determination of M &B_H
8	LCR circuits - Series
9	Measuring sugar content of a liquid using laser pointer
10	Potentiometer – Calibration of Voltmeter / Ammeter
11	Verification of Nomoto's relation for ultrasonic velocity for binary liquid mixtures.
12	De Sauty Bridge – Capacitance of a Capacitor
13	Determination of Laser wavelength using metal ruler / metal screw spacing
14	Measurement of e/m ratio of electron – using CRT
15	Bandgap measurement - Semiconductors
16	Determination of index of refraction using diffraction & Laser
17	Measurement of Hall Coefficient
18	Michelson Interferometer – Wavelength separation
19	Measurement Planck's constant – Photoelectric Effect
20	Spectral Analysis
21	Verification of Nomoto's relation for ultrasonic velocity for binary liquid mixtures.
22	Diffraction pattern of small spring using Laser and correlating with DNA pattern

PHY/PHS2672 **Physics Lab-IV** **6 Hr/ 6 Cr**

The course is to have hands-on experience in the design and fabrication of electronics experiments. Students make known with the record and process the measurements. They correlate with the respective theoretical concepts anddraw non-trivial conclusions of the significance of the experiments.

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

i. get hands-on experience in the measurements;

ii. record and process the measurements;
iii. troubleshoot electronic circuits;
iv. correlate with the respective theoretical concepts; and
v. draw non-trivial conclusions of the significance of the experiments.

Minimum of 16 Experiments should be completed.

S. No.	Experiment
1	Dual Power Supply – PCB Making
2	Dual Power Supply – Construction & Characterization
3	Phase, frequency and voltage measurements - using CRO
4	Full Wave Rectifier
5	Bridge Rectifier
6	Network Theorems
7	Zener diode Characterization – Voltage regulation
8	Wave Shaping – Clipping & Clamping
9	Transistor Characteristics
10	Single stage amplifier
11	Transistor multivibrators – Monostable & Astable
12	Square wave generation Using 555 & 741
13	Colpitt's Oscillator
14	Phase shift Oscillator
15	Hartley Oscillator
16	FET Characteristics
17	FET Amplifier
18	Op-amp – Characteristics
19	Op-amp – applications
20	Op-amp – Filters

PHY 3291 PC Management and Maintenance 3 Hr/ 2 Cr

The main objective of this course is to introduce PC, maintenance, upgrading and troubleshooting. To that end, this course helps to fully understand the family of computers including all PC-compatible systems. This course discusses most areas of system improvements, such as motherboards, processors, memory and power supply.

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

i. identify different parts of a computer;
ii. enumerate various typesof computers and troubleshoot booting problems;
iii. install operating systems and hard disk partition;
iv. perform basic maintenance operations using DOS commands; and

v. explain various tools in networking.

Unit 1 **PC Hardware – I**

Different components of a PC- input and output devices-Ports and connectors- CMOS battery- installing power supply, Processor, motherboard, RAM, drives (floppy, HDD and optical), adapter cards and internet cables

Unit 2 **PC Hardware – II**

BIOS and boot process. Compare and contrast desktop, laptop and tablet- Preventive maintenance- static electricity- identifying beep codes- troubleshooting

Unit 3 **PC Software – I**

Installing BIOS Software- installing a windows OS- command line interface- graphical user interface- partition manager- formatting partition- file systems (NTFS, FAT32 and EXT)

Unit 4 **PC Software – II**

Device Manager- disk cloning- msconfig- regedit- control panel applets-task manager- system utilities- checkdisk- defragmentation-restore point- control panel applets- preventive maintenance- troubleshooting

Unit 5 **Networking**

LAN- WAN- WLAN- peer to peer network- client server network- terminologies:-ip addressing- protocol- bandwidth- DHCP- physical components:- hubs- switches- router- wireless access points- twisted pair cable- fiber optic cable- radio waves- installing a modem- configure NIC driver and modem- attach computer to an existing network- troubleshooting

Text Book

1. David Anfinson and Kenneth Quamme, *IT Essentials- PC Hardware and Software Companion Guide*, Cisco Press (2008)

PHY 3292 **HAM Radio & Practice** **3 Hr/ 2 Cr**

This course introduces Ham radio communication to the students and enablesthemto understand the basic principles of radio communication and to gain knowledge of the various components involved in radio electronics.

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

i. state the rules and regulations involved in HAM radio communication;
ii. explain the origin of electricity and magnetism;
iii. describe the elementary theory of alternating currents in capacitors and inductors;
iv. theoretically design a basic radio receiver and transmitter; and
v. explain radio propagation and safety measures.

Unit 1 **Amateur Radio Rules & Regulation**

Amateur radio - call-sign-Different grades of licensing examinations and licenses – amateur radio rules & regulations - Radio telephony operating procedure- Radio telegraphy operating procedure- The Indian Wireless Telegraphs (Amateur Service) Rule

Unit 2 **Elementary theory of electricity & magnetism**

Elementary theory of electricity, conductors and insulators, units, Ohm's law, resistance in-series and parallel, conductance, power and energy, permanent magnets and electromagnets and their use in radio work; self and mutual inductance; types of inductors used in receiving and transmitting circuits, capacitance; construction of various types of capacitors and their arrangements in series and/or parallel

Unit 3 **Elementary theory of alternating currents**

Sinusoidal alternating quantities-peak, instantaneous, RMS, average values, phase; reactance, impedance; series and parallel circuits containing resistance, inductance, capacitance; power factor, resonance in series and parallel circuits; coupled circuits; transformers for audio and radio frequencies

Unit 4 **Radio Receiver and transmitter**

Principles and operation of TRF and superheterodyne receivers, CW reception, receiver characteristics-sensitivity, selectivity, fidelity; adjacent channel and image interference; AVC and squelch circuits; signal to noise ratio, Principles and operation of low power transmitter, crystal oscillators, stability of oscillators

Unit 5 **Radio Propagation, Aerials and other safety measures**

Wavelength, frequency, nature and propagation of radio waves; ground and sky waves; skip distance; fading**.**Common types of transmitting and receiving aerials- Measurement of frequency and use of simple frequency meters- Safety measures in a ham radio shack

Text Books

1. VigyanPrasar, *A Comprehensive Study Material for the Ham Radio Enthusiasts*, New Delhi, 2010.

PHY3293 **Bio- Medical Instrumentation** **3 Hr/ 2 Cr**

This course introduces Bio- Medical Instrumentation to the students and enables them to understand the basic principles of Instrument design and to gain knowledge of the various diagnostic and therapeutic instruments used in medical industry.

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

i. explain the basic components of medical instruments;
ii. illustrate the usage of popular diagnostic instruments;
iii. describe the principles of imaging diagnostic instruments; and
iv. elucidate the functions of popular therapeutic instruments.

Unit 1 **Instrument design**

Design of medical instruments - Components of bio medical instrumentation - Electrodes - Transducers - Amplifiers - Isolation amplifier - Instrumentation amplifier - Signal analysis

Unit 2 **Diagnostic instruments I**

Blood flow meters - Blood cell counters - Radiography - Angiography - Endoscopy

Unit 3 **Diagnostic instruments II**

X-ray - MRI scan - Ultrasonic imaging - Medical thermography

Unit 4 **Therapeutic instruments I**

Pace maker - Batteries - Artificial heart valves - Heart-lung machine

Unit 5 **Therapeutic instruments II**

Kidney machine - Physiotherapy and electrotherapy equipment

Text Book

1. M. Arumugam, *Bio-medical Instrumentation*, Ed.2, Anuradha Publications, 2003

References

2. Willard, Merritt, Dean and Settle, *Instrumental methods of analysis*, Ed.6 hill valley, California, 1996.
3. R.S. Khandpur,*Handbook of Medical Instrumentation*, Tata McgrawHill, 1999

PHY 3294 **Consumer Electronics** **3 Hr/ 2 Cr**

Consumer Electronics comprehensively covers the theory, applications and maintenance of various audio/video systems, communication systems and electronic home appliances. This course will be of help troubleshooting and maintenance of electronic gadgets.

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

i. learn the basic components used in day today electronics;
ii. explain the basic measuring devices;
iii. troubleshoot and learn the maintenance of electronic gadgets;
iv. describe the operation of house hold appliances; and
v. explain the theory and applications of various audio communication systems.

Unit 1 **Basic components and their usage**

Passive devices - Resistors - types - colour coding - capacitors - type - colour coding. – Diodes - ac to DC conversion- chokes – Transformers. Electrical charge - current - potential - units of measuring - Ohm's law

Unit 2 **Basic measuring instruments**

Galvanometer, ammeter, voltmeter and multimeter - Electrical energy - power

- watt - kWh - consumption of electrical power. ac and DC - Single phase and three phase connections - RMS and peak values

Unit 3 **House wiring and its circuits**

House wiring - overloading - earthing - short circuiting - Fuses - colour code for insulation wires - Circuit breaker. Electrical switches. Electrical bulbs- Inverter - UPS - Stabilizer -generator and motor

Unit 4 **Common house hold electrical appliances**

Fluorescent lamps-LED lamps - street lighting - flood lighting - electrical fans- electrical room heater - wet grinder - mixer - water heater - storage and instant types, electric iron box, microwave oven - induction cooker - fridge

Unit 5 **Communication gadgets and their functions**

Microphones, Headphones, loud speakers and room acoustics - Basic concepts of radio transmitter and receiver - Basic concepts of TV- Transmitter and receiver - Dish antenna - DTH system - Mobile communication system - MODEM

Text books

1. B L Theraja& A.K. Theraja, *A text book in Electrical Technology*, S Chand & Co., 2005
2. M G Say, *Performance and design of AC machines*, ELBS Edn.
3. S.P. Bali, *Consumer electronics*, Pearson education - 2005.

PHY 3575 **Solid State Physics** **5 Hr/ 5 Cr**

This course deals with the basic concepts like crystal structures, various diffraction techniques. It also deals with the theory of crystal binding and the theory of band structure and phonon. It also discuss the Physics of semiconductors and superconductivity.

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

i. determine the structure factors of fundamental crystal lattices;
ii. analyze the X-ray diffraction patterns of simple crystal structures;
iii. classify the different crystal binding forces and explain the vibrations of lattice structures;
iv. describe the quantum theories of energy bands and their consequences;
v. classify the materials based on their electrical properties; and
vi. explain the basics of superconductivity based on experimental facts.

Unit 1 **Crystal Structure and Reciprocal Lattice**

Periodic arrays of atoms – Fundamental types of lattice – Packing fraction - Index system for crystal planes – Simple crystal structures – Diffraction of waves by crystals – Bragg law – Reciprocal lattice vectors – Diffraction conditions – Brillouin zones – Reciprocal lattice to SC, BCC, and FCC lattice – Structure factor of BCC and FCC lattice – Atomic form factor

Unit 2 **Crystal Binding and Phonons**
Crystals of inert gases – Ionic crystals – Covalent crystals – Metals – Hydrogen bonds – Atomic radii – Vibrations of crystals with monatomic and diatomic basis – Quantization of elastic waves – Phonon momentum – Inelastic scattering by phonons

Unit 3 **Fermi Gas and Energy Bands**
Free electron theory in 1D and in 3D – Fermi-Dirac distribution – Density of states – Heat capacity of the electron gas – Electrical conductivity and Ohm's law – Motion of electrons in magnetic field – Hall Effect - Nearly free electron model – Bloch functions – Kronig-Penney model.

Unit 4 **Semiconductors**
Band gap - Effective mass – Silicon and germanium – Classifications of material into semiconductor, metal, and insulator - Intrinsic carrier conduction - Impurity conductivity – Donor states – acceptor states – Thermoelectric effects

Unit 5 **Superconductivity**
Experimental survey – Destruction of superconductivity by magnetic field – Meissner effect – Isotopic effect – Type I and Type II superconductors – London equation – Coherence length – BCS theory of superconductivity – Flux quantization – Vortex state – DC and ac Josephson effect – High temperature superconductors

Text Book

1. Charles Kittel, *Introduction to Solid State Physics*, Wiley-India, 7th edition , (2011)

PHY 3576 **Nuclear and Particle Physics** **5 Hr/ 5 Cr**

This course enables students to know about the properties of nucleus and the rudimentary theories of restricted validity. It helps to acquire knowledge about radiation detectors and nuclear reactors. Students are exposed to the phenomenon of radioactivity. Besides these, it helps students to know about the basics of elementary particles.

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

i. explain the stability of the nucleus and the signatures of nuclear models;
ii. classify various types of nuclear decay processes;
iii. describe the functions and characteristics of detectors and accelerators;
iv. illustrate the key features of nuclear fission and fusion and their applications; and
v. categorize the elementary particles and their symmetries.

Unit 1 **Structure and properties of Nucleus**
Nuclear size - Nuclear mass – Bainbridge mass spectrometer – mass defect – binding energy – packing fraction – semi empirical mass formula - stability – isotopes – isobars – nuclear forces – meson theory –– Fermi Gas model-liquid drop model –predictions of shell model

Unit 2 **Radioactive Decay**

Law of radioactive disintegration – law of successive disintegration - transient and secular equilibrium – carbon dating – age of earth – alpha decay: Gamow theory – beta decay: neutrino theory - Fermi theory — gamma decay: internal conversion - nuclear isomerism

Unit 3 **Radiation detectors and accelerators**

GM counter – Wilson cloud chamber – bubble chamber –photographic emulsion – accelerators: – linear accelerators – cyclotron - synchrocyclotron - betatron

Unit 4 **Nuclear reactors**

Types of nuclear reactions - Q value equation for nuclear reaction – nuclear transmutation - nuclear fission – nuclear fusion- thermonuclear reactions - chain reaction – nuclear reactor – four factor formula – atom bomb

Unit 5 **Elementary particles**

Classifications of elementary particles – particle interactions – conservation laws – CPT theorem - elementary particle symmetry — SU(3) - quarks model

Text Book

1. D.C.Tayal , *Nuclear Physics*, Himalaya Publishing House, Mumbai, 2017

PHY 3671 **Physics Lab-V** **6 Hr/ 6 Cr**

This course enables the Students to have hands-on experience in the experiments and record the process of measurements. He will also learn to correlate with the respective theoretical concepts anddraw non-trivial conclusions of the significance of the experiments.

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

i. get hands-on experience in the measurements;
ii. record and process the measurements;
iii. troubleshoot electronic circuits;
iv. correlate with the respective theoretical concepts; and
v. draw non-trivial conclusions of the significance of the experiments.

Minimum of 16 Experiments should be completed

S. No	Experiment
1	Arithmetic Circuit- Half adder and Full adder.
2	Combinational logic circuit design using 74xxICs. (For a given problem using POS or SOP)
3	Design of odd/even parity checkers - using 74180
4	Encoders - using logic gates

5	Decoders -using logic gates
6	Circuits Implementation using Software
7	Multiplexer - using logic gates
8	Demultiplexer. - using logic gates
9	Arithmetic Logic Unit (ALU) using IC 74181.
10	Construction of 1- bit comparator using 74xxICs and study of 4-bit comparator IC 7485.
11	Code converters – Binary to gray and Gray to binary.
12	Verification of basic flip flops using 74xxICs
13	Master- slave JK flip-flop using IC 7476
14	Asynchronous counter design
15	Mod-n counter. using decade counter 7490
16	3-Bit synchronous counter design
17	Shift register- SIPO/SISO
18	Shift register -PISO/PIPO.
19	Timer 555 - Construction of monostable, astable for a given frequency.
20	Storing and retrieving data (Ex-3code) - using RAM - IC 7489 or 2114.

PHY 3672 Physics Project 6 Hr/ 6 Cr

This course enables the Students to have hands-on experience in the design experiments/methodologies and record the process of measurements. He will also learn to correlate with the respective theoretical concepts anddraw non-trivial conclusions of the significance of the observations.

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

ii. extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems;

iii. plan, execute and report the results of an experiment or investigation;

iv. work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group;

v. use ICT in a variety of learning situations;

vi. express thoughts and ideas effectively in writing and orally.

Implementation

Students are given the freedom of choosing the topic of the project. It may be theoretical or experimental. After getting approval of the proposed project work within 5 sessions, students are supposed to carry out these projects in the department laboratory. They may choose computer or microprocessor interfacing projects also.

Students are encouraged to have hands-on experience in designing, fabricating, and analyzing the observations using fundamental concepts studied in the course of study.

PHY 3673 Thermodynamics & Statistical Physics 6Hr/ 6 Cr

This course enablesstudents to understand the fundamentals of thermodynamics and the concepts of entropy and enthalpy. It helps students to gain knowledge in kinetic theory and transport phenomena. This course elucidates simple applications of statistical Physics to gases.

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

i. explain the basic concepts of thermodynamicsand applications of first law of thermodynamics;
ii. apply first and second laws of thermodynamics and derive thermodynamic relations;
iii. implement laws of thermodynamics to elucidate simple thermodynamic systems;
iv. distinguish the properties of different statistical distributions; and
v. employ the principles of statistical mechanics to solve simple problems.

Unit 1 **Equations of state and First law of thermodynamics**

Thermodynamic systems - The Zeroth law of thermodynamics – Thermodynamic equilibrium – Measurement of temperature - Equation of state of an ideal gas and real gases – Expansivity and Compressibility - The first law of thermodynamics – Work in a volume change - Configuration work and dissipative work - Internal energy – Heat flow - Heat Capacity - Enthalpy - The energy equation: T and V independent - T and P independent - P and V independent - Joule-Thomson effect - Carnot cycle – The heat engine and refrigerator

Unit 2 **Thermodynamic relations**

The second law of thermodynamics – Entropy – The Tds equations: T and v independent - T and P independent - P and v independent – Entropy and Enthalpy of a pure substance, of an ideal gas, of a van der Waals gas – Helmholtz function and Gibbs function – thermodynamic potentials – Maxwell Relations - phase transitions – Clausius-Clapeyron equation - The third law of thermodynamics

Unit 3 **Applications of thermodynamics to simple systems**

Surface tension – Vapor pressure of a liquid drop – The reversible voltaic cell – Black body radiation - Kinetic theory: The principle of equipartition of energy – Classical theory of specific heat capacity – Transport Phenomena: Coefficient of viscosity - Diffusion

Unit 4 **Statistical physics**

Energy states and energy levels - macrostates and microstates – Thermodynamic probability – The Bose-Einstein statistics – The Fermi-Dirac statistics – The Maxwell-Boltzmann statistics - The statistical interpretation of entropy - BE, FD, and MB distribution functions – Comparison of distribution functions for distinguishable particles – partition function

Unit 5 **Applications of statistical physics**

The Monatomic ideal gas - The distribution molecular velocities – Ideal gas in gravitational field – The quantized linear oscillator

Text Book

1. F. W. Sears and G. L. Salinger, *Thermodynamics, Kinetic theory, and Statistical Thermodynamics*, IIIrd ed., Narosa Publishing House (1998).

PHY3674 Atomic Physics & Spectroscopy 6 Hr/ 6 Cr

This course enables the students to understand the fine structure of atom, to have greater understanding of atomic spectrum with applied fields, to gain knowledge in Molecular spectroscopy and to understand the Raman spectroscopy

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

i. explain basic atomic models and their related phenomena;
ii. describe interaction of atoms with external fields, and spectrum of many-electron atoms;
iii. elucidate the rotational spectra of molecules;
iv. interpret the vibrational spectra of molecules; and
v. explain Raman spectroscopy and its applications.

Unit 1 **Basic atomic models**

Optical spectrum of Hydrogen atom - Bohr's Postulates – Quantitative conclusions –Principal quantum number - Spectra of hydrogen-like atoms – Sommerfeld's extension of the Bohr model –Orbital quantum number –Lifting of orbital degeneracy - Limits of the Bohr-Sommerfeld theory – The Correspondence principle – Rydberg atoms –Lifting of orbital degeneracy in the spectra of Alkali atoms - Magnetic moment of orbital motion – Spin and magnetic moment of electron –Spin-orbit splitting in the Bohr model – Fine structure in Hydrogen atom

Unit 2 **Interactions with external fields and many-electron atoms**

Zeeman effect – Normal and anomalous – Stark effect - Paschen-Back effect – Double resonance and Optical pumping – The spectrum of Helium – Electron repulsion and Pauli principle – Angular momentum coupling – X-ray from outer shell & Bremsstrahlung spectra – Emission line spectra – Fine structure of X-rays – Absorption spectra – Auger effect

Unit 3 **Rotational spectroscopy**

The rotation of molecules – Rotational spectra – Diatomic molecules – Rigid molecule – Intensities of spectral line – isotopic substitution – Non-rigid rotator – Polyatomic molecules – Techniques and Instrumentation – Chemical analysis

Unit 4 **Vibrational spectroscopy**

Vibrating diatomic molecule – Diatomic vibrating rotator –Vibration – Rotation spectrum of Carbon Monoxide – Breakdown of the Born- Oppenheimer approximation – Vibration of Polyatomic molecules – Analysis by infra-red techniques - Techniques and Instrumentation

Unit 5 **Raman spectroscopy**

Classical theory & Quantum theory of Raman scattering – Pure rotational Raman spectra – Vibrational Raman spectra – Polarization of Light and the Raman effect – Structure determination from Raman and IR spectroscopy - Techniques and Instrumentation – Near IR – FT Raman spectroscopy

Text Books

1. Haken, Wolf, Springer-Verlag, *Atomic and Quantum Physics,* Second edition (1987).
2. Colin Banwell& Elaine McCash, *Fundamentals of Molecular spectroscopy*, Tata

PHY 3677 Microprocessor & Communication Systems 6 Hr/ 6 Cr

This course enables the students to understand the architecture of microprocessor and to apply it for interfacing techniques. Also to understand the basic principle of modulation and demodulation and to gain knowledge in satellite communication.

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

i. explain the architecture of microprocessor and its coding scheme;
ii. implement simple programs using assembly language;
iii. classify different types of modulation and demodulation techniques;
iv. describe various types of receiver systems; and
v. elucidate the satellite communication.

Unit 1 **Internal architecture of 8088 microprocessor**

Internal architecture of 8088 microprocessor -Software model – pipelining, memory timing diagram - Immediate, Register and Memory Addressing modes - Data transfer instruction - Arithmetic and logic instructions - control instruction - conversion of assembly language to machine language

Unit 2 **8088 hardware and simple programs**

8088 hardware – Minimum mode maximum mode systems – system clock – Read and write cycle - memory interfacing circuits - 8 bit addition – 16 bit addition & Subtraction – multiplication – ascending order – descending order – simple programs

Unit 3 **Modulation**

Modulation – Need for modulation – Amplitude modulation theory – Frequency spectrum of AM – Representation of AM – Power relation in the AM wave – Generation of AM wave – Evolution of Single Side Band - Suppression of carrier and unwanted side band - Frequency modulation –

Mathematical representation of FM – Frequency spectrum of the FM wave – Phase modulation

Unit 4 **Receivers**

Receiver type – AM receiver – RF section and characteristics – Frequency changing and tracking – Intermediate frequencies and IF amplifiers – Detection and Automatic gain control – Communication receivers – Extension of super heterodyne principle – FM receivers – Basic FM demodulators – Single and Independent side band receivers

Unit 5 **Satellite communication**

Satellite communication: Introduction – Types of Satellite orbits – Orbital perturbations – Satellite stabilization – Orbital effects on satellites performance

– Eclipses – Satellite altitude and earth coverage area – communication satellite – Frequency bands and Payloads – Satellite Telephony, Radio and Television

Text books

1. Barry.B. Brey, *Intel Microprocessors – Architecture programming and interfacing* – Fourth edition – Prentice Hall of India Pvt Ltd, 1997
2. Walter. A. Tribal &Avtar Singh, *The 8088 and 8086 microprocessors programming, interfacing, software, hardware and applications* – Prentice Hall of India Pvt Ltd, 2005.

PHY 3680 Astronomy &Astrophysics 6 Hr/ 6 Cr

This course is planned to introduce the basic concepts of astronomy. The students will familiarize themselves with instrumentation used for analyzing starlight. They are introduced to the models of universe and theories of cosmology.

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

i. summarize the birth of modern astronomy, solar system and also define basic measurements in astronomy;
ii. describe the functioning of refractor, reflector, UV and gamma ray telescopes and their extension towards spectral analysis;
iii. identify the spectral classification of stars, its magnitudes and also illustrate the birth and death of stars and to estimate the stellar magnitudes;
iv. explain types of Galaxy and Milky way galaxy and comprehend the extragalactic events; and
v. elucidate the origin of universe and various models based on cosmological principles.

Unit 1 Positional Astronomy and Gravitation

Birth of modern astronomy- Geocentric and heliocentric – the Copernicus revolution. Celestial phenomena, its connection with established (Kepler's laws - Newtonian Gravitation) and new physics; typical physical scales/conditions in astrophysics; order of magnitude estimation; Celestial sphere – coordinate systems: the ecliptic, RA/DEC coordinates, Galactic coordinates; luminosity/flux, magnitude scale, absolute/apparent magnitude - distance measurement, A.U. parsec – seasons – Eclipse – Solar, lunar - Tides and precession - solar family – inventor of solar systems – our moon – mariner and mars – Venus and mercury – the Jovian planets

Unit 2 Telescopes and Observational Methods

Astronomical observations – Telescopes: optical and infrared, reflecting, refracting, telescope mounts; telescopes' collecting area, diffraction limit, atmospheric seeing; electronic detectors – spectroscopy; Radio telescope – resolving power of radio telescope – radio interferometry; UV, X-ray, gamma ray telescopes

Unit 3 Stellar Objects

Stars and constellations. Observed stellar properties: main sequence, luminosity dependence on mass, stellar classification based on spectra, connection with Saha ionization formula, Hertzsprung- Russel diagram - magnitude of star light, stellar distances

Stellar models: hydrostatic equilibrium, gas/radiation pressure; order of magnitude estimates; opacity: Thomson, Kramer's, scattering, opacities (absorption coefficients), energy balance; nuclear energy production in stars: binding energy per nucleon, efficiencyof fusion, calculation of nuclear reaction rates, tunneling in Coulomb barrier, Gamow's calculation - important nuclear reactions in stars: pp chain, neutrino production in the Sun & consequences; CNO cycle, triple alpha reaction.

Binary stars - evolutionary stages of stars – birth of stars, main-sequence evolution, and late stages of evolution; white dwarf physics, electron degeneracy pressure, Chandrasekhar mass limit; old age star clusters, white dwarfs as dead stars; supernovae, formation of heavy objects - fate of stars

Unit 4 **Galaxy and Extragalactic Astronomy**

Galaxies; Milky Way galaxy, types of galaxies, spirals, ellipticals and irregulars, Hubble pitchfork classification.Milkyway components: gas, stars, magnetic field and cosmic rays; satellites; 21 cm line, rotation curve, dark matter; Jeans instability and star formation, HII regions; phases and components of interstellar medium; cosmic rays

Unit 5 **Basic Cosmology**

Olber's paradox; difficulty with Newtonian cosmology; modern cosmological principles – the big bang the expanding universe- cosmological model – scale of the universe – open, close universe – steady state universe – Hubble's law – maximum age of universe. Brief introduction to Einstein's general theory of relativity, especially the line element - Schwarzschild metric, horizon, orbits - FRW metric as a consequence of cosmological principle; redshift, angular and luminosity distances; evolution of scale factor from Newtonian cosmology; density parameter. Thermal history of the Universe, big bang nuclear synthesis; microwave background

Text Books

1. A. RaiChoudhuri, *Astrophysics for Physicists*, Cambridge University Press, New York, 2010
2. Carroll B. W. &Ostle, D. A, *An introduction to Modern Astrophysics*, Pearson Education- Addison Wesley, 2007