Appendix-A

B. Sc. in Physics (Honors)

Course Structure

SEM	PAPER	TITLES	Credits T+P
		F. Y. B. Sc.	
I	PYC101	Section 1 :Mathematical methods & Mechanics Section 2 :Electrical circuit Theory	2+1 2+1
II	PYC102	Section 1 :Heat and Thermodynamics Section 2 :Properties of Matter & Acoustics	2+1 2+1
		S. Y. B. Sc.	
III	PYC103	Section 1: Waves & Oscillation Section 2 : Electronics	2+1 2+1
IV	PYC104	Section 1: Optics Section 2: Modern Physics	2+1 2+1
		T. Y. B. Sc.	
V	PYC105	Section 1: Classical Mechanics Section 2: Thermal Physics	2+1 2+1
	PYC106	Analog and Digital Electronics	4+2
	PYC107	Mathematical Physics &Electromagnetic Theory I	4+2
	PYD101	Quantum Mechanics	4
	PYD102	Applied Optics	3+1
	PYD103	Solid State Physics	3+1
	PYD104	Medical Physics	3+1
	PYD105	Experimental Techniques in Physics	3+1
Any two papers from PYD101 to PYD105			
VI	PYC108	Atomic and Molecular Physics	4+2
	PYC109	Solid State Devices and Instrumentation	4+2
	PYC110	Electromagnetic Theory II & Theory of Relativity	4+2
	PYD106	Nuclear Physics	4
	PYD107	Introduction to Astronomy & Astrophysics	3+1
	PYD108	Physics of Communication	3+1
	PYD109	Project	4
	Any two papers from PYD106 to PYD109		

Generic elective courses (GE) (Appendix B)

(From the minutes of the BOS in Physics meetings held on 5th March 2018)

PYG101: BASIC PHYSICS
PYG102: OPTICS and INSTRUMENTATION
PYG103: ACOUSTICS AND NOISE CONTROL
PYG104: BIOPHYSICS and BIOMEDICAL INSTRUMENTATION

S**kill enhanced courses (SEC)** (Appendix C)

(From the minutes of the BOS in Physics meetings held on 5th March 2018)

PYS101: NETWORK ANALYSIS
PYS102: COMPUTATIONAL PHYSICS using FORTRAN
PYS103: COMPUTATIONAL PHYSICS using C
PYS104: DOCUMENTATION AND VISUALIZATION
PYS105: ELECTRICAL AND ELECTRONIC INSTRUMENTATION
PYS106: MICROPROCESSOR ARCHITECTURE AND PROGRAMMING
PYS107: MICROCONTROLLER ARCHITECTURE AND PROGRAMMING
PYS108: PHOTOGRAPHY

SEMESTER I

PYC101: MATHEMATICAL METHODS, MECHANICS

and

ELECTRICAL CIRCUIT THEORY

SECTION 1: MATHEMATICAL METHODS AND MECHANICS

(Theory 2 Credits)

- **Mathematical methods [15 Lectures]**

Matrices and determinants, Linear equations [**2]**

System of linear equations, matrices and determinants.

Elementary Vector Algebra **[2]**

Scalars and vectors, addition and subtraction of vectors, multiplication by a scalar, basis vectors and components, magnitude of a vector, unit vector, dot and cross product of vectors and their physical interpretation.

Complex numbers **[2]**

Complex numbers, notation of complex number, complex planes, physical meaning of complex quantities, exponential, logarithmic and trigonometric functions, hyperbolic functions. De'Moivre's Theorem, Roots of unity.

Limits and Continuity **[3]**

Definition, intervals and neighborhoods, algebra of limits, limits of trigonometric functions, exponential limits. Concept of continuity, left and right hand limits, graphical representation of continuity.

Differentiation **[3]**

Differentiation from first principles, derivative of polynomials, trigonometric, exponential, logarithmic functions and implicit functions. Rules of differentiation, Leibnitz theorem, higher order derivatives.

Integration **[3]**

Integration from first principles, integration as inverse of derivative, integration by inspection. Standard Integrals: (Algebraic, trignometric, exponential logarithmic), integration by parts, substitution methods, reduction formulae).

- **Mechanics [15 Lectures]**

Motion of a particle in one dimension **[10]**

Discussion of the general problem of one dimensional motion. Dependence of force in general on position, velocity and time. Motion under a constant force with illustrations - Atwood'smachine, free fall near the surface of the earth. Motion along a rough inclined plane. The equation of motion, momentum and energy conservation theorems. Motion under a force which depends on time-general approach to the solution. Illustration using force of the type $F = F_o \sin(\omega t + \varphi)$. Motion under a conservative force dependent on position, potential energy. Motion under damping force depending on velocity - general dependence of resistive force on velocity. Motion in a medium with resistive force proportional to first power of velocity. Body falling under gravity in a resistive medium near the surface of the earth.

Motion in two dimensions : **[5]**

Equations of motion in plane polar coordinates. Momentum and energy theorems. Plane and vector angular momentum theorems.

Projectile motion in a non-resistive and resistive medium, (resistive force proportional to the first power of velocity).

Text Books & References

1. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical methods for Physics and Engineering, Cambridge University Press (2006).
2. Robert Stainer and Philip Schmidt, Mathematics for Physics students, Schaum series, 2007.
3. K. R. Symon, Mechanics, Addison Wesley (1962).
4. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997).
5. C. Kittel, W. D. Knight, M. A. Rudderman, A. C. Helmhotz and B. J. Moyer, Berkeley Physics Course, Volume I, Mechanics, McGraw-Hill (1973).
6. Eugine Hecht, College Physics, Schaum Outline Series, 2011.
7. P. V. Panat, Classical Mechanics, Narosa Publishing, (2013).
8. D. S. Mathur, Mechanics, S. Chand & Co. (1981).
9. Gupta, Kumar and Sharma, Classical Mechanics, Pragati Prakashan, Merut (2008).

PYC101

MATHEMATICAL METHODS AND MECHANICS

Practical (any four) (1 credit)

Introduction to measurement techniques:

Range and least count of instruments, measurements using various instruments and error analysis (Vernier calipers, micrometer screw gauge, travelling microscope, spherometer, spectrometer).

1. Graphical analysis of one-dimensional motion: Kinematics, plotting and interpretation of displacement, velocity and acceleration versus time graphs. Linear and nonlinear plots, determination of slopes and area under the curves for evaluation of physical quantities such as force, work and energy.
2. Motion in resistive medium (Experimentation/Simulation).
3. Atwood's machine.
4. Fly wheel: Determination of frictional couple and moment of inertia of a flywheel.
5. Projectile Motion (Experimentation/Simulation).
6. Bar pendulum
7. Conical Pendulum
8. Torsional Pendulum

PYC101

SECTION 2: ELECTRICAL CIRCUIT THEORY

(Theory 2 Credits)

Circuit Analysis [7]

Concept of constant current and constant voltage source, Maxwell's cyclic current method for circuit analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem (with proof) and their application to simple networks.

Inductance [4]

Self Inductance, self inductance of two parallel wires carrying equal current in opposite directions, Principle of non-inductive resistance coils, self inductance of co-axial cables, mutual inductance, coefficient of coupling, inductance in series and parallel.

Response of circuits containing L, C and R to DC [6]

Growth and decay of current in L-R circuit, Charging and discharging of capacitor in C-R circuit and in a series L-C-R circuit.

AC Circuits [7]

AC applied to L-R and C-R circuits, Inductive and Capacitive reactance, impedance and admittance, The j operator and vector or phasor method applied to LR, CR and LCR circuits. Series and parallel resonance. Q factor and Bandwidth. Graphic representation of resonance (Variation of resistance, inductive reactance, capacitive reactance with frequency)

Mutually Coupled L-R circuits [3]

AC applied to mutually coupled L-R circuits. Reflected impedance. Transformers, Effect of loading the secondary of a transformer.

AC Bridges [3]

General AC bridges, Maxwell's bridge, Maxwell's L/C bridge,De-Sauty's bridge. Wein's frequency bridge.

Text Books & References

1. J. Yarwood and J. H. Fewkes, Electricity and Magnetism. University Tutorial Press (1991).
2. D. N. Vasudeva, Fundamentals of Electricity and Magnetism, S. Chand and Company Ltd. New Delhi.(2012)
3. Brijlal and Subramaniam, Electicity and Magnetism, Ratan Prakashan, New Delhi. (1966).
4. Mahmood Nahvi, Joseph Edminister, Electrical Circuits, Schaum outline Series, (2002).
5. Thereja B.L. Text Book of Electrical Technology, S. Chand and Co Ltd. New Delhi (1990).
6. Sudhakar and Shammohan, Circuits and Networks Analysis and Synthesis, TMH, (2006).

PYC101

SECTION 2: ELECTRICAL CIRCUIT THEORY

Practical (any four) (1 credit)

1. Verification of Thevenin's Theorem & Maximum Power transfer theorem
2. Verification of Norton's theorem & Maximum Power transfer theorem
3. Response of LR and CR circuits to AC - phasor diagrams.
4. Step Response of CR circuit / LR Circuit.
5. De Sauty's Bridge- comparison of capacitance and Maxwells L/C Bridge- determination of mutual inductance
6. LCR Series and parallel resonance –Resonant frequency, Q value and Bandwidth.
7. Resistance of Mirror Galvanometer / Table Galvanometer by Shunting.
8. Figure of Merit of Mirror Galvanometer and Determination of Current and Voltage Sensitivity.

SEMESTER II
PYC102: HEAT & THERMODYNAMICS

And

PROPERTIES OF MATTER & ACOUSTICS

SECTION 1: HEAT AND THERMODYNAMICS I

(Theory 2 Credits)

Kinetic theory of gases [8]

Three states of matter, concept of ideal gas, postulates of Kinetic Theory of gases, expression of pressure of a gas, relation between rms velocity and temperature, Average kinetic energy of a gas molecule, heat and temperature, kinetic interpretation of temperature, Degrees of freedom, Law of equipartition of energy and its application to specific heats of gases. Brownian motion and its features, Einstein's equation, Determination of Avogadro's number. Mean free path and derivation to calculate MFP, Transport phenomena, transport of momentum (viscosity).

Behavior of real gases [7]

Deviation from perfect gas behavior, Discussion of results of Andrew's experiments on CO2 and Amagat's experiment, critical constants, Van der Wall's equation of state, expression of Wan der Wall's constants, Reduced equation of state, Law of corresponding state, relation between Boyle temperature and critical temperature, critical coefficient.

Zeroth and First Law of Thermodynamics [4]

Basic concepts of thermodynamics: Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics and concept of temperature, Internal energy and First law of thermodynamics, Relation between pressure, volume and temperature in adiabatic process, Work done in isothermal and adiabatic processes, Path dependence of heat and work.

Second Law of Thermodynamics [7]

Process-reversible and irreversible, condition of reversibility, Second law of thermodynamics, Carnot's cycle, efficiency of Carnot's cycle, reversibility of Carnot's cycle, Carnot's theorem, coefficient of performance of a refrigerator, Thermodynamic scale of temperature, its identity with perfect gas scale, Clapeyron latent heat equation and its applications.

Entropy [4]

Entropy as a Thermodynamic variable, Entropy change in reversible and irreversible processes, Temperature–Entropy diagram of Carnot's Cycle, Entropy of a perfect gas, Physical significance of Entropy: Entropy and Unavailable Energy, Entropy and molecular disorder, Entropy and

Second Law of Thermodynamics. Impossibility of attaining Absolute Zero (Third law of Thermodynamics).

Text Books & Reference Books:

1. Treatise on heat, M. N. Saha and B. N. Shrivastava, The Indian Press (1965).
2. Thermal Physics, S.C . Garg, R.M. Bansal and C. K. Ghosh, TMH (1993).
3. Thermodynamics J.K. Roberts and A.R Miller , E.L.B.S. (1960).
4. Text Book of Heat, G.R. Noakes, Mcmilan& Co(1960).
5. Thermodynamics, William C .Reynolds (1968).
6. Heat and Thermodynamics M.W. Zemansky and R.H. Ditman, McGraw Hill (1997).
7. Heat, Thermodynamics and Statistical Physics, BrijLal, N. Subrahmanyam and P. S. Hemne, S. Chand.

PYC102

SECTION 1: HEAT AND THERMODYNAMICS I

Practical (any four) (1 credit)

1. Determination of Stefan's constant.
2. Resistance Thermometry (Cu wire and Pt 100).
3. Thermistor- NTC /PTC
4. Study of thermocouples for temperature measurement
5. Constant volume air thermometer.
6. Constant pressure air thermometer.
7. Calibration of Si diode as a temperature sensor.
8. Measurement of thermal conductivity of good conductors- by any method

PYC102

SECTION 2: PROPERTIES OF MATTER AND ACOUSTICS

(Theory 2 Credits)

Elasticity: **[10]**

Brief review of moment of Inertia. Modulii of elasticity, Strain energy, equivalence of shear to compression and extension at right angles to each other, Poisson's ratio and its limiting values, Relationship between the elastic constants. Torsion in a string-couple per unit twist, Torsional Pendulum. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. Theory of Loaded pillars, Critical load for pillars.

Surface Tension: **[4]**

Brief review of molecular theory of surface tension. Relation between surface tension andsurface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity, experimental determination of surface tension and angle of contact.

Flow of liquids and Viscosity: **[3]**

Streamline flow, Turbulent flow, Critical velocity. Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Viscosity of gases – Mayer’s formula.

Acoustics: **[10]**

Differential equation for harmonic oscillator, Velocity of longitudinal waves in fluids. Newton's formula for velocity of sound, vibrations in stretched strings. (transverse and longitudinal modes). Vibration in rods. Superposition of two simple harmonic motions, standing waves and beats, Helmholtz resonator.

Doppler effect. Intensity level - Bel and Decibel.

Production and detection of Ultrasonic waves and its applications.

Reverberation of sound **[3]**

Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine’s formula for reverberation time, Acoustic requirements of an auditorium.

Text Books and References

1. Elements of Properties of Matter, by D. S. Mathur, S. Chand and Sons, (2013).
2. Lectures in elementary fluid dynamics, by J. M. McDonough (Lecture Notes available on Net, free download).
3. Fluid Mechanics by R K Bansal, Firewall Media, (2005).
4. Fluid Mechanics by Merle Potter, David Wiggert, Schaum Outline Series, (2008).

5. Continuum Mechanics by George Mase, Schaum Outline Series. (1969).
6. Text book of Sound by Khanna and Bedi, Atma Ram, New Delhi, 1969.

PYC102

SECTION 2: PROPERTIES OF MATTER AND ACOUSTICS

Practical (any four) (1 credit)

1. Bending of beams-single cantilever: determination of Young's modulus.
2. Bending of beams-double cantilever: determination of Young's modulus.
3. Velocity of sound by forming stationary waves by using C.R.O.
4. Young's modulus by transverse vibrations of rods /strips.
5. Capillarity: determination of Surface tension.
6. Viscosity of a liquid by Poiseuilles method.
7. Verification of Bernoulli's theorem.
8. To measure the velocity of flow using Pitot tube.
9. To determine the viscosity of fluid by viscometer.
10. Frequency of AC cycle using amplitude resonance
11. Kundt's tube experiment

SEMESTER III
PYC103: WAVES & OSCILLATIONS

And

ELECTRONICS

SECTION 1: WAVES AND OSCILLATIONS

(Theory 2 Credits)

Waves and Oscillations: **[10]**

Periodic oscillations and potential well, differential equation for harmonic oscillator and its solutions (case of harmonic oscillations), kinetic and potential energy. Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, Helmholtz resonator, bifilar oscillations.

Superposition of Waves: **[8]**

Wave equation and solutions, Superposition of two simple harmonic motions of the same frequency along the same line, interference, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency, Lissajous figures, case of different frequencies.

Oscillatory Motion in a Resistive Medium: **[12]**

Damped harmonic oscillator, Damped forced harmonic oscillator. Displacement and velocity Resonance, Sharpness of resonance, Phase relationships, Energy consideration in a forced harmonic oscillator. Harmonic oscillator with an arbitrary applied force.

Text Books and References:

1. Takawale R. G. and Puranik P S. Introduction to Classical Mechanics, TMH, 1997
2. D. R. Khanna and R.S. Bedi, Text book of Sound,Atma Ram, New Delhi (1994).
3. N. K. Bajaj, Physics of Waves and Oscillations, TMH, 2006.
4. A P French, Waves and Oscillations, CBS Publishers, 2003
5. H. J. Pain, Physics of Vibrations and waves, 6^{th} Ed, Wiley, India, 2005
6. Brijlal and Subrahmanyam, Waves and Oscillations and Accoustics, S Chand & Co Ltd.(2009)
7. D. Chattopadhyay and P.C. Rakshit, Waves and Oscillations, Books and Allied Pvt Ltd (2009)
8. M Ghosh and B Bhattacharya, Oscillations and Accoustics, S Chand & Co Ltd. (1976).
9. S.P.Puri, Text book of Vibrations and Waves, Macmillan India ltd, 2nd edition, 2004

PYC103

SECTION 1: WAVES AND OSCILLATIONS

Practical (any 4) (1 credit)

1. Bifilar oscillations Determination of η using Flat spiral spring.
2. Determination of η using Flat spiral spring.
3. Determination of Y using Flat spiral spring.
4. Y by vibrations of cantilever.
5. Superposition of two mutually perpendicular simple harmonic oscillations -Lissajous figures using CRO.
6. Helmholtz resonator.
7. Simulation of Waves
8. . Resonance pendulum –study of amplitude resonance and determination of ‘g’
9. Double pendulum

PYC103

SECTION 2: ELECTRONICS

(Theory 2 Credits)

Rectifiers and Regulators **[6]**

Volt-ampere characteristics of Junction diode, Half wave, Full wave and Bridge rectifiers using Junction diodes without and with capacitive filters. Percentage regulation, Ripple factor and Rectification efficiency. Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation.

Transistors **[3]**

Basic configurations of transistors, Transistor characteristic in CE and CB mode, Current gains α and β and their interrelation, Leakage current in transistors.

Basic Amplifier Characteristics **[3]**

Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Conversion efficiency, Classes of amplifier operations, Decibel, Frequency response, Amplifier bandwidth.

C-E amplifier: Class A **[4]**

Graphical analysis, Effect of adding A.C. load, Input and Output resistance, Conversion efficiency, Phase relationship between input and output.

Transistor Biasing **[4]**

Bias stability, Stability factor, Different methods of biasing, biasing compensation.

Feedback **[5]**

Positive and negative feedback, Voltage and current feedback, series and shunt feedback.

Effect on negative feedback on gain, frequency response, input and output resistance and distortion. **Positive feedback,** Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, LC tank circuit, Hartley oscillator and Colpitts oscillator.

Linear IC's and Operation Amplifiers **[5]**

The Differential Amplifier, OP-Amp characteristics, Input and Output impedance, Input bias and offset currents, Input and output offset voltages. Differential and Common mode gains, CMRR, Slew rate, OP-Amp as inverting , Non Inverting amplifier and Difference amplifier.

Text Books and References

1. A.P.Malvino, Electronic Principles –TMH 5th edition (1996).
2. Allen Mottershed, Electronics Devices and Circuits an Introduction- 3rd edition PHI (1997).
3. Millman and Halkias, Intergrated electronics- TMH (1972).
4. Bhargava, Kulshrestha and Gupta, Basic Electronics and Linear Circuits-. TMH (1984).

5. Ramakant Gayakwad, Op-amp and Linear Intergrated Circuits, PHI (2002).

PYC103

SECTION 2: ELECTRONICS

Practical (any four) (1 credit)

1. Half wave and Full wave rectifier using Junction Diode, Load regulation characteristics.
2. Bridge rectifier with capacitor filter- Ripple factor using CRO.
3. Zener Diode Regulation.
4. Colpitts / Hartley oscillator
5. Wein's Bridge /Phase shift Oscillator.
6. Transistor characteristics- Input and Output (C E mode)
7. C.E. Amplifier. Fequency response with and without negative feedback. Calculation of Gain Bandwidth product.
8. C.E. Amplifier -Determination of Input and Output Impedance, Variation of Gain with load
9. OP-Amp: Inverting and Non-inverting amplifier.
10. Op-Amp : Differential amplifier & adder/subtractor

SEMESTER IV
PYC104: OPTICS

And

MODERN PHYSICS

SECTION 1: OPTICS

Interference [9]

Introduction: Interference by division of wave front & division of amplitude. Fresnel's biprism and Lloyd's mirror.

Formation of colors in thin film- reflected system, Transmitted system, wedge shaped film, Newton's Rings and its application to determine refractive index of liquids (Normal Incidence only).

Interferometry:- Michelson interferometer-its principle, working and its application to determine wavelength and difference between two wavelengths. Fabri Perot Interferometer.

Diffraction [12]

Concept of Diffraction, Fresnel and Fraunhoffer Diffraction. Division of cylindrical wave-front into half period strips, Fresnel's diffraction at straight edge and cylindrical wire. Fraunhoffer diffraction at single, double and N slits. Diffraction grating, width of principal maxima of plane diffraction grating. Resolving power of optical instruments- Rayleigh's criterion, Resolving power of telescope, Prism and grating.

Polarization [9]

Concept of polarization, Plane of polarization, Polarization by reflection, Brewster's law, Polarization by refraction, Double refraction, uniaxial and biaxial crystals, positive and negative crystals, Nichol's Prism, Circularly and Elliptically polarized light - Theory and analysis, Polaroid, Retardation plates - Quarter wave plate and Half wave plate, Optical activity, specific rotation, simple polarimeter, Laurent's half shade polarimeter.

Text Books and References

1. N Subrahmayam and N.Brijlal, Text Book of Optics, S. Chand & Company Ltd,(1991).
2. Optics, AjoyGhatak, Tata McGraw-Hill Publicashing Company Limited. (1977).
3. Ghatak And Tyagrajan, Contenprary Optics, Mc Millan (2003).
4. R. S Longhurst, Geometrical and Physical Optics, Orient Longman (1976 Indian edition).
5. Francis A Jenkins and Harvey E White, Fundamentals of Optics, (1976).

6. D N VasudevaA textbook of light for B. Sc. students (1962).
7. B.K. Mathur and T P Pandya,Principles of Optics, New Global Printing Press, Kanpur. (1980).

PYC104

SECTION 1: OPTICS

Practical (any four) (1 credit)

1. Spectrometer: Determination of dispersive power of prism..
2. Cardinals points of two lenses.
3. Wedge shaped film – determination of wavelength
4. Fresnel Biprism
5. Newton's rings - determination of radius of curvature of lens
6. Single slit Diffraction using Na source
7. Diffraction Grating.
8. Resolving power of telescope using wire mesh.
9. Verification of Brewster's law.

PYC104

SECTION 2: MODERN PHYSICS
(Theory 2 Credits)

Motion of charged particles in electric and magnetic fields [6]

Lorentz force , Motion in a uniform electric field, magnetic field, parallel and crossed fields.

Electric discharge through gases, Determination of e/m for cathode rays, Charge and mass of an electron, Atomic masses, Energy and mass units.

Particle Accelerators [3]

Linear accelerator and Cyclotron.

Atomic Physics [6]

Measurement of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph. Review of Bohr's Hydrogen atom, Correction due to finite nuclear mass. Frank-Hertz experiment and atomic energy levels.

Properties of electromagnetic radiation [7]

Black Body Radiation, Kirchoff's radiation law, Stefan's law, Wien' law, Raleigh - Jean's law, Planck's law. Photoelectric effect and Compton Effect – observation, description, derivations of relevant equations and failure of classical physics to explain the same. Experimental verification of the Photoelectric and Compton effects.

Crystal Structure [3]

Crystal lattice,crystal planes and Miller indices, unit cells, typical crystal structures.

X-rays [5]

Coolidge tube generator, Continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, Wave nature of X-rays – Laue's pattern, Diffraction of X-rays by crystal, Bragg's law, Bragg single crystal spectrometer, Analysis of crystal structure - simple cubic crystal.

Text Books and References

1. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985).
2. S.B. Patel, Nuclear Physics, TMH (1991).
3. Irving Kaplan, Nuclear Physics, Narosa Publishing House,(1997).
4. F.K. Richtmyer, E.H. Kennord, J.N. Cooper Introduction to Modern Physics, McGraw Hill (1997).
5. H.Semat and J.R.Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1973).
6. J.B.Rajam, Atomic Physics, S.Chand and Co. Ltd.(1950).

7. K. Thyagrajan and A. Ghatak Laser: Theory and Applications, McMillan (2009).
8. K.Thyagarajan and A.Ghatak, Optical Electronics, Cambridge University Press (1997).
9. B.B.Laud, LASERs and Non-linear optics, Wiley Eastern (1991)

PYC104

SECTION 2: MODERN PHYSICS
Practical (any four) 1 credit

1. Frank Hertz Experiment.
2. Characteristics of photo cell.
3. Measurement of K/e using transistor.
4. Photocell (verification of Photoelectric effect).
5. To determine the Planck's constant using LEDs of at least 4 different colours.
6. Measurement of emissivity of hot bodies (various types of surfaces).
7. X-ray emission (characteristic lines of copper target) – calculation of wavelength and energy and assigning transitions.
8. Calculation of lattice constant by of Copper – x-ray diffraction pattern is given and student calculates, d-spacing, miller indices and lattice constant.

SEMESTER V

PYC105
CLASSICAL MECHANICS and THERMAL PHYSICS
(Theory 4 credits)

Classical Mechanics:

Motion of a system of particles **[7]**

Center of mass coordinates, applications of conservation laws for linear momentum, angular momentum and energy - rockets, conveyor belts and planets, critique of conservation of laws. The collision problems, the two body problem, reduction to equivalent one body problem.
(Ref: [1,2,3]).

Motion under a central force [**10]**

General features of motion, qualitative discussions of orbits under inverse square law force field. Nature of orbits, elliptical orbits, Kepler's problem, hyperbolic orbits, classical scattering, definition of scattering cross section, impact parameter and scattering angle, Rutherford's scattering cross section. (Ref: [1,2]).

Moving coordinate systems **[7]**

Inertial and non- inertial coordinate frames, rotating coordinate systems, laws of motion on the rotating earth, Coriolis force, Foucault's pendulum, and Larmor's theorem. (Ref: [2,4]).

Rigid bodies **[6]**

Rotation about an axis, moment of inertia tensor, Euler's equations of motion of a rigid body, torque free motion, qualitative discussion of motion of a symmetric top.
(Ref: [1,2,4]).

Thermal Physics:

Power cycles. **[3]**

Internal Combustion Engines – The Otto cycle and its efficiency, Diesel cycle and its efficiency.
(Ref: [6,7]).

Production of low temperature. **[13]**

Cooling by evaporation. Vapour compression machines. Refrigerators based on Vapour absorption. Cooling by sudden adiabatic expansion of compressed gases. Efficiency and performance of refrigerating machines. Enthalpy and heat flow. Joule Kelvin effect. Expression for Joule Kelvin coefficient and inversion temperature. Application to Van der Waals' gas. Principles of regenerative and cascade cooling. Liquifaction of hydrogen and helium. Production of temperatures below 4^{o} K. Properties of He I and He II. Cooling by Adiabatic Demagnetisation of paramagnetic substances. (Ref: [4,6,7,8]).

Probability **[7]**

Random Events, Probability, Probability and Frequency, Some basic rules of Probability theory, Continuous random variables, Mean value of discrete and continuous variables, Variance: Dispersion, Probability Distribution, Binomial distribution: Mean value and fluctuation, Stirling's Approximation, Poisson Distribution: Mean value and Standard deviation, Gaussian Distribution: Standard deviation. (Ref: [9,10]).

Statistical Distributions: **[7]**

Concept of Phase space, Probability of distribution and most probable distribution. Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and rms speeds. Experimental verification of Maxwell Boltzmann distribution law (Zartman ko experiment). Bose Einstein and Fermi Dirac statistics (qualitative study). (Ref: [4,6,11]).

References

1. K. R. Symon, Mechanics, Addison Wesley (1971).
2. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997)
3. Gupta, Kumar and Sharma, Classical Mechanics, Pragati Prakashan.
4. A.V. Namjoshi, J.A. Rao, Classical Mechanics Thermal and Statistical Physics (T.Y. B.Sc Vol. III), Sheth Publishers Pvt. Ltd.
5. C.L. Arora & P.S. Hemne, Physics for Degree Students, S. Chand
6. Brij Lal & Subrahmaniam, Heat Thermodynamics and Statistical Physics, S. Chand Publications.
7. M.N. Saha and B.N. Shrivastava,Treatise on heat, The Indian Press(1965).
8. M.W. Zemansky and R.H. Ditman, Heat and Thermodynamics, McGraw Hill (1997).
9. B.B. Laud Introduction to Statistical Mechanics, New Age International (2008).
10. N. Joshi, S.G. Chitale, G. Venkat, S.R. Rege, Statistical Techniques,
11. Perspectives of modern physics – Arthur Beiser, McGraw hill (1995).

PYC105

CLASSICAL MECHANICS and THERMAL PHYSICS
(Practical 2 credits)

Minimum of total 8 experiments, but at least 3 experiments from each section

Classical Mechanics

1. Kater's Pendulum.
2. To investigate the motion of coupled oscillators.
3. Surface tension by Quinke's method
4. Y by Koenig's method
5. To determine "Y" by optical lever

6. Viscosity of liquid using Stokes method
7. Verification of parallel & perpendicular axis theorem – using Moment of Inertia
8. Determination of Log decrement & viscosity

Thermal Physics

9. To determine temperature coefficient of Pt_{100}
10. Specific heat of graphite.
11. Measurement of thermal conductivity of poor conductors. –by Lee's method
12. Measurement of thermal conductivity of good conductors – by Searle's method
13. Computer simulation of Maxwell-Boltzmann distribution, Fermi- Dirac & Bose-Einstein

PYC106
ANALOG AND DIGITAL ELECTRONICS
(Theory 4 credits)

Analog Electronics:

Transistors Multivibrators. **[6]**

Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.

Field Effect Transistors. **[11]**

Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier (only qualitative discussion), The MOSFET Depletion Mode and Enhancement mode, Dual-Gate MOSFET. FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.

Applications of OP-AMP. **[6]**

Active diode circuits, Intergrator, Differentiator, Comparator, Window comparator, Schmitt Trigger, Waveform generator –Square wave, Triangular and Ramp Generator and monostable.

Voltage Regulation: **[3]**

Fixed voltage regulation using IC-78 & 79 series, adjustable voltage regulators using IC LM-317.

Timers: **[4]**

IC-555 Timer : basic concept, block diagram, Monostable, Astable and Voltage controlled oscillator (VCO).

Digital Electronics:

Number system Logic. **[15]**

Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, OR, AND, NOR, NAND, and EX-OR, Bubbled OR and Bubbled AND gates. De Morgan's Law's, Boolean Algebra, NAND and NOR gates as universal building blocks in logic circuits, Sum of Products methods and Product of Sum methods of representation of logical functions. Binary addition and Subtraction, Half adder and Full adder, Multiplexer and Demultiplexer. Encoders and decoders

Logic families – DTL, TTL Standard TTL NAND gate, Schottky TTL, ECL OR and NOR gate, MOS (inverter, NAND and NOR gates) and CMOS (inverter, NAND and NOR gates).

Flip Flops and Counters. **[15]**

Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept, 3 bit Shift register (shift left, shift right), Applications of FF's in counters, 3 bit count up/count down binary ripple counter, Mod 3, Mod 5, Mod 7 Counters, BCD Decade Counter, Cascade BCD Decade counters, Principle of digital clock.

Books and References:

1. A.P. Malvino, Electronic Principles: TMH.(2007).
2. Allen Mottershed, Electronics Devices and Circuits An Introduction: PHI (1997).
3. Millman and Halkias, Electronic Devices and Circuits, Mc Graw Hill (1967).
4. Millman and Halkias, Intergrated Electronics, TMH (1971).
5. V.K.Metha, Principles of Electronics, S.Chand & Company (2009).
6. Malvino and Leach, Digital Principles and Applications, TMH (1986).
7. R. P. Jain, Modern Digital Electronics, TMH (2003).
8. Ramakant Gayakwad, Introduction to operational amplifier, PHI.

PYC106
ANALOG AND DIGITAL ELECTRONICS
(Practical 2 credits)

Minimum of total 8 experiments, but at least 3 experiments from each section

Analog Electronics

1. Study and analysis of transistorised Multivibrators- Astable, Monostable.
2. Study and analysis of transistorised Multivibrators- Bistable, Schmitt trigger.
3. F.E.T Characteristics & F.E.T Common Source Amplifier.
4. Op-Amp as a differential (Instrumentation) amplifier and its application in temperature measurement.
5. Op-Amp as a square wave generator & integrator
6. Regulated power supply using IC LM 317 with external pass transistor.
7. Study of IC 555 as Astable & VCO / Monostable multivibrator.

Digital Electronics

8. Analog / Digital Multiplexer.
9. Verification of De Morgan Laws and Boolean Identities. (Construction using Gates).
10. Binary addition- Half adder and Full adder using logic gates.
11. NAND and NOR gates as universal building blocks.
12. Study of JK flip flop with JK FF IC's (Ripple counter and Decade counter).

PYC107

MATHEMATICAL PHYSICS & ELECTROMAGNETIC THEORY I

(Theory 4 credits)

MATHEMATICAL PHYSICS

Vector Analysis [15]

Vectors and scalar fields, differentiation and integration of scalar and vector fields, directional derivative, gradient, the del operator, divergence and curl, Laplacian operator, Integration of Vector Functions - Line, Surface and Volume Integrals, Gauss Divergence Theorem (without proof), Greens Theorem, Stokes Theorem (without proof), Differential vector Identities, Expression for Laplacian operator in Cartesian, spherical and cylindrical coordinates. Dirac delta function and its application. (Ref: [1,2,3,4,5]).

Differential equations [10]

Partial differentiation - definition of the partial derivative, Total differential, Chain rule, Exact and inexact differentials, Useful theorems of partial differentiation, Change of variables, Partial differential equations and separable solutions, Problems (Schaum Series).
(Ref: [1,2,3,4])

Some special functions in Mathematical Physics [5]

Introduction to Legendre's equation, Legendre polynomials and Fourier series, Introduction to beta and gamma functions. (Ref: [1,2,3,4])

ELECTROMAGNETIC THEORY I

Electrostatics [6]

Coulomb's Law, Electric Field and electrostatic potential, Continuous Charge distribution, field lines, flux and Gauss' law with applications, the electric dipole- field and potential. (Ref: [5]).

Techniques to solve electrostatic problems [8]

The electrostatic potential, Poisson's equation, Laplace's equation in one independent variable, solutions to Laplace's equation in spherical co-ordinates (zonal harmonics), conducting sphere in a uniform electric field, method of electrostatic images, point charge in front of grounded conducting plane.
(Ref: [5]).

Electric Fields in matter [6]

Polarization, Fields outside a dielectric medium, electric field inside a dielectric, Gauss's law in a dielectric, the electric displacement vector, electric susceptibility and dielectric constant. Boundary conditions on the field vectors, Dielectric sphere in a uniform electric field. (Ref: [5]).

Microscopic Theory of Dielectrics [5]

Molecular field in a dielectric, induced dipoles, A simple model, polar molecules, Langevin-Debye formula, permanent polarization, ferroelectricity. (Ref: [5]).

Work and Energy in electrostatics **[5]**

Work and Potential energy of discrete and continuous charge distributions, Energy density of an electric field.

Books and References

1. Charlie Harper, Introduction to Mathematical Physics, PHI, (1976)
2. H.K. Dass & R. Verma, Mathematical Physics, S. Chand.
3. Mary L Boas, Mathematical methods in physical sciences, John Wiley and sons (1983)
4. Arfken & Weber, Mathematical Methods for Physicists, Elsevier.
5. Reitz and Milford, Foundations of Electromagnetic Theory, Addision- Wesley Publishing Company.(2008)
6. David Griffiths, Introduction to Electrodynamics , Prentice Hall of India Ltd, New Delhi (1995)
7. Mahajan and Rangawala, Electricity and Magnetism, Tata McGraw-Hill Publishing Company Ltd., 1988
8. Chatopadhaya and Rakshit, Electricity and Magnetism, New Central Book Agency, (2013)

PYC107
MATHEMATICAL PHYSICS & ELECTROMAGNETIC THEORY I
(Practical 2 credits)

Students must perform minimum 5 experiments from electromagnetic theory and minimum of 3 tutorials from mathematical physics.

Electromagnetic Theory I

1. Measurement of Dielectric constant of solids by using parallel plate capacitor.
2. Measurement of dielectric constant & susceptibility of liquid using two co-axial metal tubes
3. Absolute capacity by ballistic galvanometer.
4. Verification of Curie -Weiss law using a disc capacitor.
5. Equipotential lines & electric field
6. Variation of A.C. Resistance of a coil with frequency.
7. Dielectric constant K and Electric Susceptibility χ_e using series resonance method.
8. Determination of high resistance by leakage using ballistic galvanometer
9. Resistance of ballistic galvanometer by shunting.

Mathematics Physics tutorials

10. Proof of differential vector identities.
11. First order differential equation.
12. Second order differential equation.
13. Partial differential equations
14. Application of Fourier Series to solution of ODF
15. Application of Fourier Series to solution of PDE

PYD101
QUANTUM MECHANICS
(Theory 4 credits)

Waves and particles **[7+2T]**

De Broglie's hypothesis, Review of the Bohr's postulate about stationary states in the light of De Broglie's hypothesis, The concept of quantum (particle) nature of radiation.
Demonstration of wave nature of particles-Davisson Germer experiment, electron diffraction experiment of G.P.Thomson, Dual nature of radiation/matter. Complimentary in Duality.
(Ref: [1,2,3]).

The Wave Function **[5+2T]**

Representation of a De Broglie wave, Velocity of De Broglie wave, Construction of a wave group, Wave packet and its motion in one dimension., Group velocity and particle velocity, Max Born's interpretation of the wave function, probability concept, Acceptable wave function, Normalization of wave function.
(Ref: [1,2,3]).

Heisenberg's Uncertainty Principle **[5+2T]**

Limitation of wave mechanics to predict the physical state of a particle/system accurately.
Heisenberg Uncertainty principle. Illustration by thought experiments (γ - ray microscope, single slit diffraction and double slit experiment), Applications of Heisenberg Uncertainty principle.
(Ref: [1,2,3]).

Schroedinger's Wave Equation **[12+4T]**

Wave equation for De Broglie waves and Schroedinger's time dependent wave equation, Concept of stationary states. Schroedinger's time independent equation. Postulates of Quantum mechanics, Definition of operators & their necessity, Expectation values, Extraction of information from solutions in terms of expectation values of physical variables/observable. Eigen value equation, Commutation relations.
(Ref: [1,2,3]).

Applications of Schrödinger's Time Independent Wave Equation **[16+5T]**

Free particle, Infinite square well potential: Energy eigen functions and eigen values,
One dimensional finite square step potential of height Vo: Comparison of classical and quantum mechanical results for particle energy E>Vo and E<Vo, Rectangular potential barrier and penetration through it, tunnel effect, Qualitative discussion of alpha decay, tunnel diode & scanning tunneling microscope. Simple Harmonic Oscillator – Energy eigen values and eigen functions (Operator method), Calculation of $\langle x \rangle$ and $\langle p_x \rangle$, $\langle x^2 \rangle$ and $\langle p_x^2 \rangle$. Particle in a three dimensional box, Concept of degeneracy.
(Ref: [1,2,3]).

Books and References

1. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1995).
2. Arthur Beiser, Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995).
3. P.S. Bangui & others, New Course in Physics, Sheth Publishers.
4. F.K. Richtmayer, E.H.Kennard, J.N. Cooper, Introduction to Modern Physics (1969).
5. H. Semat and J.R.Albright, Introduction to Atomic and nuclear Physics, HRW (1972).
6. Ghatak and Lokanathan, Quantum Mechanics, Theory and Applications, Mc Millan (2004).

PYD102
APPLIED OPTICS
(Theory 3 credits)

LASERS [5]

Purity of a spectral line, Coherence length and coherence time, Spontaneous and stimulated emissions, population inversion, Theory of laser action, Einstein's coefficients, Properties of lasers, Three level and four level laser systems. (Ref: [1,4,9])

Types of lasers: [8]

Ruby Laser, He-Ne laser, CO_2 laser, Nd^3YAG laser, Pulsed nitrogen lasers, Excimer lasers, dye lasers, Semiconductor lasers. *Energy Levels, Radiative and Nonradiative Transitions in Molecules and Semiconductors*-Principle of Semiconductor Laser Operation, Distributed Feedback and Distributed Bragg Reflector Lasers. Applications of lasers in Medicine, Industry and Science. (Ref:[1,9]).

Optical properties of semiconductors [4]

Excitation absorption, donor-acceptor and impurity band absorption, long wavelength absorption. (Ref:[5,6,9])

Solid state lamps: [5]

Basics of solid state lamps-LED materials and device configuration, efficiency, high brightness LEDs, Light extraction from LEDs, LED structures-SH, DH, SQW, MQW, Device performance characteristics. Manufacturing processing and applications- White solid state lamps.

(Ref:[7,8,9])

Holography [3]

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition. (Ref:[1]).

Fibre Optics [5]

Optical fibres and their properties, Principal of light propagation through a fibre, refractive index profile, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres. (Ref: [9,10,11,12]).

Fibre optic sensors: Fibre Bragg Grating. [15]

Fabrication and characterization of Polymer fibres, Erbium doped fibres, Fibre components - Packaging, Splicers, Cable, Fiber joints, fiber couplers, connectors, Applications of optical fibers- Fibre Optic communication- basic principle, Transmission characteristics of optical fibre, attenuation, absorption and scattering losses, nonlinear losses, wavelengths for communication, bend losses, dispersion effects in optical fibres, Wavelength Division Multiplexing, telemetric applications. (Basic principles), Industrial, medical and technological applications of optical fibre.

(Ref: [9,10,11,12])

Books and References:

1. LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
2. Ghatak and Thyagarajan, An introduction to Fiber Optics, Cambridge University Press 1998
3. Fibre optics through experiments,M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
4. Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
5. S. M. Sze Physics of semiconductor devices- John Wiley Eastern 2nd Edition, (2002) ISBN-9971-51-266-1
6. S. C. Gupta, Optoelectronic devices and systems –PHI, (2005)
7. Zukaszukasu, Sold State Lighting- John Wiley Sons, NY (2002)
8. Ben G Streetmann and Sanjay Banerjee Solid state Electronic devices-, PHI (2003) 5th Edition, ISBN-81-203-1840-4
9. S. L. Kakani and Subhra Kakani, Photonics/Optoelectronics, CBS Publishers, (2016).
10. J. Gowar, Optical Fibre communication systems - Prentice Hall India (1995)
11. J. Palais, Fibre optic communication - Prentice Hall India (1988)
12. B. P. Pal, Fundamentals of Fibre Optic Telecommunication - Wiley Eastern (1994)

PYD102
APPLIED OPTICS

Practical (any four) 1 credit

1. Characterisation of LASERS – Solid state, He-Ne and LED.
2. Characteristics of opto-couplers.
3. Characteristic of photodiode and photo-transistor.
4. Design, construction and testing of photo-detector.
5. Optical fiber communication.
6. Optical fiber characterisation (numerical aperture, bending loss, refractive index of core & cladding).
7. Fiber optic sensors – multimode.
8. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
9. To find the polarization angle of laser light using polarizer and analyzer.
10. Study the characteristics of solid state laser.

PYD103
SOLID STATE PHYSICS
(Theory 3 credit course)

Crystal Structure: **[10]**

Solids - Amorphous and Crystalline Materials, Lattice Translation Vectors, Basis, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Brillouin zones, Diffraction of X-rays by Crystals, Bragg's Law. (Ref: [1,3,4,5]).

Free electron theory of metals: **[5]**
Drude's Free electron model, Fermi Dirac distribution, thermionic emission, Contact potential. (Ref: [2,4,5]).

Band theory of metals: **[7]**
Electrons in periodic lattice, Kronig Penny Model (Qualitative Approach) Effective mass of electron, Concept of hole. Classification of materials based on band structure. Effect of magnetic field on electrons, Hall effect. (Ref: [2,4,5]).

Magnetic Properties of Matter: **[9]**

Diamagnetic, Paramagnetic, Ferrimagnetic and Ferromagnetic Materials. Classical Langevin Theory of diamagnetic and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. (Ref: [1,4,5]).

Dielectric Properties of Materials: **[7]**

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, Tranverse optic modes. (Ref: [1,2,3,4]).

Ferroelectric Properties of Materials: **[7]**

Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop. (Ref: [1,2]).

Books and References:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Solid State Physics, A. J. Dekker, McMillan, 1969
3. Solid State Physics, S.O. Pillai, Mc-Graw Hill.
4. Solid State Physics, Gupta, Kumar & Sharma,
5. New Course in Physics, Gogawale & Lele, Vol. I. Sheth Publishers
6. Millman & Halkias, Electronic Devices and Circuits, Mc-Graw Hill.
7. Principles of Electronic Materials and Devices, S.O. Kasap,
8. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, PHI

9. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
10. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
11. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
12. Solid State Physics, Rita John, 2014, McGraw Hill
13. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
14. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

PYD103

SOLID STATE PHYSICS

Practical (any four) 1 credit

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. Measurement of magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. Variation of Dielectric Constant of a dielectric Materials with frequency
5. To study the P E Hysteresis loop of a Ferroelectric Crystal.
6. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
7. To measure the resistivity of a semiconductor (Si/Ge) with temperature by any method (room temperature to 150^{o}C) and to determine its band gap.
8. To determine the Hall coefficient of a semiconductor sample.
9. Energy band gap using PN junction.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

PYD104
MEDICAL PHYSICS
(Theory 3credits)

PHYSICS OF THE BODY-I **[10]**

Mechanics of the body: Skeleton, forces, and body stability. Muscles and the dynamics of body movement, Physics of body crashing.

Energy in the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body,

Pressure system of the body: Physics of breathing, Physics of the cardiovascular system.

PHYSICS OF THE BODY-II **[10]**

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.

Optical system of the body: Physics of the eye.

Electrical system of the body: Basic Physics of the nervous system, Electrical signals and information transfer.

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I **[7]**

X-RAYS: Electromagnetic spectrum – production of x-rays – x-ray spectra- Brehmsstrahlung- Characteristic x-ray – X-ray tubes – Coolidge tube – x-ray tube design – tube cooling stationary mode – Rotating anode x-ray tube – Tube rating – quality and intensity of X-ray. X-ray generator circuits – half wave and full wave rectification –filament circuit – kilo voltage circuit – high frequency generator – exposure timer – HT cables.

RADIATION PHYSICS: **[6]**

Radiation types and units - exposure - absorbed dose – units: rad, gray -relative biological effectiveness - effective dose - inverse square law - interaction of radiation with matter - linear attenuation coefficient. Radiation Detectors –Thimble chamber- condenser chambers – Geiger counter – Scintillation counter – ionization chamber, semiconductor detectors.

MEDICAL IMAGING PHYSICS: **[10]**

X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR) – NMR imaging– MRI Radiological imaging –Radiography –X-ray film – fluoroscopy –computed tomography scanner – principle function – display – generations –mammography. Ultrasound imaging – magnetic resonance imaging

Basic elements of Nuclear medicine **[2]**

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Single photon and positron emission tomography.

PYD104
MEDICAL PHYSICS
Practical ((Any four) one credit

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the construction of speaker-receiver system and to design a speaker-receiver system of given specification.

Reference Books:

1. Medical Physics, Vol 1 and 2 by Hartmut Zabel , Deb Gruyter, (2017).
2. ***R. S. Khandpur,*** Handbook of ***Biomedical Instrumentation***, Second Edition. Front Cover. . Tata Mcgraw-hill Pub, 1992 Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978)
3. Dr. K. Thayalan, Basic Radiological Physics - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
4. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology , Lippincot Williams and Wilkins (1990)
5. Irving P. Herman, Physics of the human body, Springer (2007).
6. F M Khan, Physics of Radiation Therapy : - Williams and Wilkins, 3rd edition (2003)
7. Bushberg, Seibert, Leidholdt and Boone, The essential physics of Medical Imaging, Lippincot Williams and Wilkins, Second Edition (2002)
8. H E Johns and Cunningham, The Physics of Radiology

PYD105
EXPERIMENTAL TECHNIQUES IN PHYSICS
(Theory 3 credits course)

Physical measurement: Measurement, The result of a measurement, Sources of uncertainty, Experimental errors, Types of error- Systematic & random, Common sense in errors, Definition of uncertainty, The analysis of repeated measurements, Mathematical description of data and distribution function, properties of distribution functions, Propagation of error, Analysis of data, Multi-parameter experiments. Problems (10)

Laboratory instruments and experimental methods: Meter rule, vernier capilars & micrometer screw guage (choice of method), Temperature effect on length measurement, beat method of measuring frequency, negative feed-back amplifier, servo systems, natural limit for measurement, Experiment design, Choice of transducers, Modeling external circuit components and circuit calculations, Instrument probes, power measurements, DC & AC bridge measurements, Measurement methods. Exercise. (10)

Experimental logic: Cause of experimental mistakes, Apparent symmetry in apparatus, sequence of measurements, intentional & unintentional changes, drift, systematic variations, Calculated and empirical corrections, Need for precise measurements, Experimental common sense (Chapter 9 , Practical Physics by G.L.Squires, Cambridge Low Price Edition) (10)

Signal to noise considerations in measurement system: Fluctuations & noise, noise in frequency domain, sources of noise, signal to noise & experimental design, Frequency & band width considerations, band width control, signal to noise enhancement – Phase sensitive lock-in amplification & detection, digital & auto correlation methods, Frequency measurements using Fourier analysis and Fast Fourier transform (10)

Experiment documentation techniques: Techniques of Recording of observations & Calculations, Use of Graphs, Arithmetic- Use of computers & calculators, Calculation checks & Error calculations, Result analysis & conclusion (5)

References:

1) Physics by G.L.Squires, Cambridge Low Price Edition
2) Measurement Instrumentation & Experiment Design in Physics & Engineering, Michael Sayer & Abhay Mansingh, PHI publications

PYD105
EXPERIMENTAL TECHNIQUES IN PHYSICS
(Practical 1 credit)

Laboratory work: (Students are expected to design & perform at least three experiments from the following list. Experimental data generated must be used to perform error analysis)

- Measurement of resistances 100 M Ohms to 0.1 Ohms

- Reighley refractometer
- Absolute measurement of acceleration due to gravity
- Measurement of frequency by Fourier analysis & Fast Fourier Transformation
- Measurement of Stefan’s constant
- Measurement of Seebeck coefficient

SEMESTER VI

PYC108
ATOMIC AND MOLECULAR PHYSICS
(Theory 4 credits)

Hydrogen Atom **[6]**

Schrodinger's equation for the H-atom, separation of variables, Quantum numbers-n, l, m_l, spin, magnetic moment, J and m_J, Angular momentum, Magnetic moment and Bohr magneton.
(Ref: [1,2,3]).

Many Electron Atoms **[10]**

Pauli exclusion principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions, Electron configuration, Hund's rule, Spin orbit interaction, Vector atom model, Total angular momentum, L-S coupling, J-J coupling.
(Ref: [1]).

Atomic Spectra **[8]**

Spectroscopic notation, Selection rules (derivation from transition probabilities), Alkali metal type spectra, Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra.
(Ref: [1]).

Atoms in a Magnetic Field **[8]**

Effects of magnetic field on an atom, The Stern-Gerlach experiment, Larmor Precession, The Normal Zeeman effect, Lande 'g' factor, Zeeman pattern in a weak field (Anomalous Zeeman effect). (Ref: [1,4]).

X-ray Spectra **[6]**

Characteristic spectrum, Moseley's law, Explanation of X-ray spectra on the basis of quantum mechanics, Energy levels and characteristic X-ray lines, X-ray absorption spectra, Fluorescence and Auger effect. (Ref: [4]).

Spectra of Diatomic Molecules **[14]**

Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibration-Rotation spectra, Fortrat Parabolas and explanation of band structure on its basis, Electronic spectra
(Ref: [5,7,10]).

Raman Effect **[8]**

Raman Effect: Classical and Quantum mechanical explanation, Pure rotational Raman spectra, Vibrational Raman spectra, Rotational fine structure, Experimental set up for Raman spectroscopy.
(Ref: [10])

Books and References:

1. Arthur Beiser, Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995)

2. F.K. Richtmayer, E.H.Kennard, J.N. Cooper, Introduction to Modern Physics (1969)
3. H.E.White H.Semat and J.R.Albright, Introduction to Atomic Physics, McGraw Hill Book Company (2003)
4. H.Semat and J.R.Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1972)
5. Barrow, Introduction to Molecular Physics, McGraw Hill (1962)
6. Anne P. Thorne, Spectrophysics, Chapman and Hall(1974)
7. Banwell, Fundamentals of Molecular Spectroscopy, TMH (2012)
8. P.T. Matthews, Introduction to Quantum Mechanics, TMH (1974)
9. Ghatak and Lokanathan, Quantum Mechanics, Theory and Applications, Mc Milan (1967)
10. G. Arhuldas, Molecular Structure & Spectroscopy, PHI.

PYC108
ATOMIC AND MOLECULAR PHYSICS
(Practical 2 credits)

Minimum of 8 experiments

1. To determine the wavelength of H-alpha emission line of Hydrogen atom. Hydrogen source / Rydberg Constant
2. Balmer series & Emission spectra
3. Determination of specific rotation of optically active substances.
4. To determine the value of e/m by helical method.
5. Absorption spectrum of a liquid $KMnO_4$ or KI
6. To determine the charge of an electron using Millikan oil drop apparatus
7. Resolving fine structure of Sodium D lines using Diffraction (reflection/ transmission) grating
8. Determination of Cauchy's constants of a given Flint glass prism using fine structure of Na D lines
9. To determine refractive index of liquid by hollow prism
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.
11. Analysis of Rotational / Vibrational spectra to find bond length and bond strength
12. Zeeman effect
13. GM counter

PYC109

SOLID STATE DEVICES AND INSTRUMENTATION

(Theory 4 credits)

Solid State Devices:

Two Terminal Devices **[10]**

Power diodes, Tunnel diodes, Varicap diodes, Schottky Barrier diode, Semiconductor photoconductive cell, Photovoltaic cell, Photodiode, Light emitting diodes (LED), Liquid Crystal display (LCD), Solar cells and Photocouplers. (Ref: [1,3]).

Industrial Devices **[15]**

Silicon controlled rectifier (SCR), SCR characteristics, rating, construction and terminal identification, SCR applications, Silicon controlled switch (SCS), Gate turn off switch (GTO), Light activated SCR (LASCR), Shockley diode, Diac, Triac, Typical Diac-Triac Phase control circuit, Unijunction transistor (UJT), Phototransistor. (Ref: [1,3]).

Image Capture Devices **[5]**

Solid State Image scanners (CCD's), Basic LED TV. (Ref: [2]).

INSTRUMENTATION:

Measuring Instruments **[12]**

Errors in measurement, Basic PMMC, Analog DC ammeter, Multirange ammeter, Universal shunt, DC & AC voltmeter, Multirange voltmeter, Extending voltmeter range, Transistor voltmeter, Ohmmeter – Series and shunt type, Multimeter, Digital voltmeter, Resolution and sensitivity of digital meters, multimeter, frequency meter, Q meter. (Ref: [6,7,8]).

Oscilloscope **[4]**

CRT, CRO block diagram (simple CRO), vertical and horizontal deflection system, Vertical amplifier, sweep generator, Delay line. (Ref: [6,7,8]).

Transducers **[10]**

Introduction, Electrical transducer, selecting a transducer, Resistive transducers, Strain gauges, resistance wire gauge, types of strain gauges, foil strain gauge, semiconductor strain gauge, Resistance thermometer, Thermistor, Inductor transducer, LVDT, Capacitive transducer, Piezo electric transducer and Hall effect transducers. (Ref: [6,7,8]).

Signal Generator **[4]**

Standard signal generator, AF sine and square wave generator, Function generator.
(Ref: [6,7]).

Books and References

Solid State Devices:

1. Robert Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11t Ed. PHI (2009)

2. R.R. Gulati Monochrome and Colour TV, 2nd Ed., New Age International, 2005.
3. Allen Mottershed, Electronic Devices and Circuits An Introduction: PHI (1997).
4. Malvino, Electronic Principles, TMH (2007).
5. J. Millman and C. Halkias, Electronic Devices and Circuits , Mc Graw Hill (1972).
6. H. S. Kalsi, Electronic Instrumentation: TMH (2004).
7. William David Cooper, Electronic Instrunentation and Measurement Techniques, PHI (2003).
8. A. K. Sawhney A course in Electrical and Electronic Measurement, Dhanpat Rai and Co.(2001).

PYC109
SOLID STATE DEVICES AND INSTRUMENTATION
(Practical 2 credits)

Minimum of 8 experiments

1. Light emitting diode V-I characteristics, determination of Planck's constant & Energy gap
2. Photodiode /Photo-transistor: Characteristics, Variation of conductivity with Intensity and spectral response,
   Application as a switch
3. UJT characteristics and its use in relaxation oscillator.
4. SCR characteristics and gate-controlled ac half wave rectifier.
5. DIAC& TRIAC Characteristics, Gate triggering application.
6. Design and Construction of analog two range voltmeter & ohmmeter.
7. Solar cell characteristics (V-I at different wavelengths), spectral response, maximum power point
8. Determination of transition capacitance of Varactor diode as function of reverse bias voltage and use as
   a variable/tuning capacitor in any one application. (Type CD91 or Bel 90 or equivalent).
9. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquid medium, different liquids/ same liquid
   at different temperatures.
10. Study of strain Gauges to determine Young's Modulus.
11. Study of LVDT - calibration and its use in any one application.
12. Signal Generator XR 2206

PYC110
ELECTROMAGNETIC THEORY II & THEORY OF RELATIVITY
(Theory 4 credits)

Steady currents and their magnetic fields **[8]**

Steady currents, current density, Biot-savart's law and its applications, Ampere's circuital law, magnetic vector potential, magnetic field of a distant circuit, magnetic dipoles, dipole moment and the field of a point magnetic dipole, magnetic scalar potential. (Ref: [1]).

Magnetic Field in material media **[12]**

Magnetization, magnetic field produced by magnetized material, magnetic pole density, sources of the magnetic field, magnetic intensity H (Auxiliary magnetic field), The field equations, magnetic susceptibility and permeability, Hysteresis, Boundary conditions on **B** and **H** vectors, current circuits containing magnetic media, Magnetic circuits, Magnetic circuits containing permanent magnets. (Ref: [1]).

Microscopic Theory of Magnetism **[6]**

Molecular field inside matter, Origin of Diamagnetism, Origin of Paramagnetism, theory of Ferromagnetism, Ferromagnetic domains, ferrites. (Ref: [1]).

Magnetic Energy **[5]**

Magnetic energy of coupled circuits, Energy density in the magnetic field, Hysteresis Loss. (Ref: [1]).

Maxwell's Equations **[6]**

Faraday's Law of electromagnetic induction, Generalization of Ampere's Law- Displacement current, Maxwell's equations and their empirical basis, Electromagnetic energy-Poyntings theorem. (Ref: [1]).

Experimental Background of the Theory of Special Relativity **[7]**

Galilean Transformations, Newtonian Relativity, Michelson Morley Experiment, Attempts to preserve the concept of a preferred Ether frame, (Lorentz-Fitzgerald Hypothesis), Einstein's Postulates of Special Relativity. (Ref: [6,7])

Relativistic Kinematics **[6]**

Relativity of Simultaneity , Derivation of the Lorentz Transformations and derivation of its consequences such as Length Contraction and Time dilation, Relativistic Addition of velocities, Aberration and Doppler Effect. (Ref: [6,7])

Relativistic Dynamics **[10]**

Dynamics and relativity, Need to redefine momentum, Relativistic Momentum, Relativistic Force law, and dynamics of a single particle, Longitudinal and transverse mass, Equivalence of mass and

energy E= Mc^2, Lorentz transformation of Momentum, Energy, Mass and Force, Twin Paradox (qualitative approach). (Ref: [6,7])

Books and Reference Books: -

1. Reitz and Milford, Foundations of Electromagnetic Theory, Addision- Wesley Publishing Company (2008).
2. David Griffiths, Introduction to Electrodynamics , Prentice Hall of India Ltd, New Delhi (1995).
3. Mahajan and Rangawala, Electricity and Magnetism, TMH, , (1988).
4. Chatopadhaya and Rakshit, Electricity and Magnetism, New Central Book Agency, (2013).
5. P. Lorrain, D. Corson, Electromagnetic Fields and Waves, 1988.
6. Robert Resnik, Introduction to Special Relativity Wiley(1968).
7. N.C. Garach, Understanding Relativity, Vol. I, Sheth Publishers

PYC110
ELECTROMAGNETIC THEORY II & THEORY OF RELATIVITY
(Practical 2 credits)

Students must perform minimum 6 experiments and 2 tutorials.

Experiments

1. Measurement of Core losses and copper losses in a transformer
2. Measurement of Hysteresis loss using CRO.
3. Hysteresis by magnetometer
4. To study Hall effect, measurement of hall coefficient and its application as a transducer
5. Self inductance: Rayleigh's method
6. Mutual inductance by ballistic galvanometer.
7. Mutually coupled tuned series LCR circuits
8. Magnetic circuit – determination of flux and reluctance
9. Helmholtz coil & measurement of Faraday's number
10. Magnetic susceptibility of paramagnetic substances by Guoy's Balance

Tutorials

11. Problems on length contraction/ time dilation
12. Problems on relativistic velocity addition
13. Twin Paradox
14. Pole –Barn Paradox

PYD106
NUCLEAR PHYSICS
(Theory 4 credits)

Nuclear Properties **[5]**

Constituents of nucleus, Isotope, Isotone & Isobar, Radii & Density of nucleus, Definition of a.m.u, Mass of nuclei, Mass defect, Packing fraction, Binding energy, Stability of nuclei, Magnetic and electrical dipole moments.

Nuclear forces **[5]**

Main characteristics of nuclear forces; Deuteron problem that reveals tensor/ non-central nature of nuclear force, meson theory of nuclear forces, estimation of mass of meson using Heisenberg's Uncertainity Principle; Yukawa potential.

Radioactivity **[10]**

Law of radioactive decay; Derivation of expression for exponential decay, half & mean life, statistical nature of radioactive phenomenon, Problems, Successive radioactive transformation (A→B→C type); ideal, transient and secular equilibrium; radioactive series; Radioactive-carbon dating, Applications, Problems

Nuclear Reactions [8]

Artificial transmutation, Definition, Compound nucleus, Types of nuclear reactions, Conservation laws, Energetics of nuclear reactions, Q value, Threshold energy of endoergic reactions, cross sections of nuclear reactions, Discovery of neutron, Determination of neutron mass, Problems

Radioactive Decay **[12]**

Alpha decay: Velocity and energy of alpha particles; Alpha disintegration energy; Geiger-Nuttal law, alpha spectra and fine structure; short range and long range alpha particles; Gamow theory of alpha decay (qualitative treatment);

Beta decay: Types of beta decay; energies of beta decay; the continuous beta particle spectrum; difficulties in understanding the spectrum; Pauli's neutrino hypothesis; Fermi's theory of beta decay (qualitative treatment); K capture

Gamma decay: Origin of the decay; internal conversion and nuclear isomerism.

Nuclear Models **[10]**

Liquid drop model; compound nucleus theory; analogy between liquid drop and the nucleus; Wiezsacker's semi empirical mass formula; mass parabolas; prediction of stability against decay for members of an isobaric family; spontaneous and induced fission; Bohr-Wheeler theory of nuclear fission and condition for spontaneous fission on the basis of Z/A; Estimation of energy released from binding energy curve and from energy – mass equivalence.

Nuclear Shell Model: Experimental evidence for magic numbers; evidences that led to shell model, main assumptions of the single particle shell model; Jensen-Mayer scheme (no derivation); predictions of the shell model- Spin and Parity

Nuclear energy **[7]**

Neutron induced fission; chain reaction; mass yield in an asymmetrical fission; neutron cycle in a thermal nuclear reactor (the four factor formula) Structure of nuclear reactor and it's working; principle of a breeder reactor; Nuclear Program in India- Nuclear Energy , Nuclear test (Pokhran-I & II), Nuclear submarine

Detection of nuclear radiation **[3]**

Ionization chamber; proportional chamber; Geiger Muller counter; Photographic emulsions; Semiconductor detectors

Text Books / References:

1. Irving Kaplan, Nuclear Physics, Narosa Publishing House
2. Atomic and Nuclear Physics, A.B.Gupta and Dipak Ghosh, Books and Allied (P) Ltd
3. Arthur Beiser, Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995)
4. F.K. Richtmyer, E.H. Kennord, J.N. Cooper, Introduction to Modern Physics, (6th Ed.) McGraw Hill (1997).
5. S.B. Patel, Nuclear Physics, TMH ().
6. Nuclear Physics , K. Ilangovan, MJP publishers

PYD107

INTRODUCTION to ASTRONOMY AND ASTROPHYSICS
(Theory 3 Credits)

Introduction to Astronomy **[5]**

Introduction of astronomy and astrophysics. Importance and scope of astronomy. Methods of astronomy and astrophysics. The scientific method. Kepler's laws, radiation from hot objects, Wien's law, radiation curve and Doppler effect.

[Abhyankar 1.1 - 1.5]

2. Celestial coordinates **[7]**

Spherical coordinate system. Celestial sphere. The coordinate system: Azimuth & Altitude, Right ascension and Declination of a star. Latitude & Longitude, Equatorial, Ecliptic and Galactic system of co-ordinates. Conversion of one coordinates system to another. Rising and setting of celestial bodies.

[Abhyankar 2.1 – 2.8]

3. Scales and measurements in Astronomy **[7]**

Units of measurement in astronomy: Astronomical Unit, Light year, Parsec. Measuring distances within solar system. Measuring distances in Universe: Parallax method. Standard Candle method. Cepheid variable method. Red Shift.

[Abhyankar 4.1 – 4.3]

4. Stellar structure and Star system **[8]**

Basic Properties of a Star: Size, mass, brightness, luminosity, magnitude, colour and temperature.The Hydrostatic Equilibrium, Star formation and Proto stars. Classification of stars. Birth of star: Protostar, The Main Sequence Hertzsprung-Russel (HR Diagrams). End of a star: White Dwarf. Supernova. Neutron Stars and Black Holes, Chandrashekhar limit.

[Abhyankar 3.2, 9.1,9.2] [Maoz 4.1-4.5] [Choudhuri 3.2.1, 3.2.4, 3.6, 4.7]

5.Galaxies and Milky Way **[10]**

Morphology of galaxy, Galaxy formation and Evolution. Radio galaxies. Seyfert galaxies. Hubble classification of galaxy. Types of galaxies:Elliptical galaxies, Spiral galaxy, Lenticular galaxies, Irregular galaxies. Distance, luminosity, size and mass of galaxies.

Mass and size of the Milky way Galaxy. Interstellar Medium and its composition. Distribution of stars in the solar neighbourhood.

[Choudhuri 6.1] [Abhyankar 14.1, 14.2,14.6,15.1,17.1,17.2] [Schneider 3.1, 3.2, 3.3]

6. Astronomical Instruments **[8]**

Types of telescopes. Optical telescopes: light gathering power, Magnifying power, Resolving power. Radio telescopes. Infrared and Ultraviolet telescopes. X-ray telescopes. Design and construction of an optical telescope. Schmidt telescopes. Optical astronomy. Infrared astronomy. Ultraviolet astronomy. Radio astronomy. X-ray astronomy and gamma ray astronomy. Orbiting Space based telescope.

[Abhyankar 19.1 - 19.5] [Choudhuri 1.7]

PYD107

INTRODUCTION to ASTRONOMY and ASTROPHYSICS

Practical (any four) 1 credit

1. Measurement of the solar constant.
2. Study of scattering of light (Diameter of Lycopodium powder).
3. To determine the elements in sun using Fraunhofer spectra.
4. To estimate Astronomical Unit using Venus transit data by parallax method.
5. Verification of Stefan's fourth power law.
6. Study of solar spectrum.

Reference books

1. K.D. Abhyankar, Astrophysics: Stars and Galaxies (University Press, 2001).
2. D. Maoz, Astrophysics in a Nutshell AKA basic astrophysics (Princeton University Press 2007).
3. Peter Schneider, Extragalactic Astronomy and Cosmology an introduction (Springer 2006).
4. A. R. Choudhuri, Astrophysics for Physicists (Cambridge University Press 2010).
5. Seed Backman, Foundations in Astronomy and Astrophysics (Cengage Learning 2013).
6. M. Sandage and J.Kristian, Galaxies and the Universe (University of Chicago Press).
7. Gordon Walker, Astronomical Observations - an Optical Perspective (Cambridge University press).
8. Jayant Naralikar, The Structure of Universe
9. S. Chandrashekher ,An Introduction to Stellar Structure.

PYD108
PHYSICS OF COMMUNICATION
(Theory 3 credits)

Electronic communication: **[6]**
Introduction to communication systems. Need for modulation and frequency allocation for radio communication system. Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

Analog Modulation: **[8]**
Amplitude Modulation, modulation index and frequency spectrum,
Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection.
Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Super heterodyne receiver.

Analog Pulse Modulation: [**4]**
Channel capacity, Sampling theorem, Basic Principles of PAM, PWM, PPM modulation and detection technique for PAM only, Multiplexing.

Transmission Lines: **[4]**
Introduction, Transmission line, Constants, Characteristic impedance, Propagation constant, Standing waves & SWR.

Fundamentals of Antenna systems: **[5]**
Principles of radiation, Isotropic radiator, Hertzian dipole, Antenna gain, Directivity, Antenna array-Broad side and End-fire, Yagi-Uda antenna, Radiation resistance.

Digital Communication: [**8]**

Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), and Binary Phase Shift Keying (BPSK).

Satellite Communication – Introduction, Geosynchronous satellite orbits, geostationary satellite, advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and downlink.

Fundamentals of Cellular Communication: **[10]**
Concept of cellular mobile communication – cell and cell splitting, frequency bands used in cellular communication, absolute RF channel numbers(ARFCN), frequency reuse, roaming and hand off, authentication of the SIM card of the subscribers, IMEI number, concept of data

encryption, architecture (block diagram) of cellular mobile communication network, GSM and CDMA technology- an overview, simplified block diagram of cellular phone handset, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Reference Books:

1. Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
2. Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
3. Modern Digital and Analog Communication Systems, B.P. Lathi, 4th Edition, 2011,
4. Oxford University Press.
5. Electronic Communication systems, G. Kennedy, 3rd Edn., 1999, Tata McGraw Hill.
6. Principles of Electronic communication systems – Frenzel, 3rd edition, McGraw Hill
7. Communication Systems, S. Haykin, 2006, Wiley India
8. Electronic Communication system, Blake, Cengage, 5^{th} edition.
9. Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press
10. Electronic Communication , Taub & Schilling, Mc-Graw Hill.
11. B. Grob & M.E. Schultz, Basic Electronics, Glencoe/Mcgraw-Hill.

PYD108
PHYSICS OF COMMUNICATION
Practical (minimum four experiments) (1 credits)

1. Amplitude modulation and demodulation.
2. To study AM Transmitter and Receiver
3. To study FM Transmitter and Receiver
4. To study Pulse Amplitude Modulation (PAM)
5. To study Pulse Width Modulation (PWM)
6. To study Pulse Position Modulation (PPM)
7. To study ASK, PSK and FSK modulators
8. Frequency modulation and demodulation.
9. Analog/Digital multiplexer
10. Sample and Hold Circuit.
11. Study of super heterodyne radio receiver.
12. Study of Antennas
13. Characteristic impedance of Transmission lines.

Appendix B

PYG101: BASIC PHYSICS

(4 credits theory paper)

Measurement of Physical quantities, standards and units. **[5]**

Length: radius of proton to size to astronomical distances.

Mass: atomic mass unit to mass of earth.

Time: time for fast elementary particle to pass through nucleus to age of earth.

Units in electricity: volts, Amperes, ohms.

Units of Temperature: Celsius scale, Kelvin scale.

International systems and units: Units used to measure physical quantities and their inter-conversion.

Properties of matter **[12]**

Elasticity: Hook's law, modulii of elasticity.

Surface tension: Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity. **Application of the phenomenon to life sciences**.

Fluid Statics and fluid dynamics**:** Pascal's Principle, Measurement of pressure. Various units of pressure and their inter-conversion, Concept of pressure energy. Bernoulli's theorem and its applications- Venturi meter and Pitot's tube. Viscosity, Viscosity estimation by Oswald's viscometer. Relevance to life sciences.

Acoustics **[12]**

Loudness, units of intensity and loudness, Weber Fechner law and sound absorbers.

Production and detection of Ultrasonic waves and its applications. Doppler effect. Calculation of apparent frequency, (Normal incidence only), application to life sciences.

Acoustics of Building : Growth and decay of intensity, Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time (discussions only) , Acoustic requirements of a good auditorium.

Basics of Electrostatics and Electricity: **[10]**
Electric charge. Coulomb's law. Applications of electrostatics in life sciences.

Basics of electricity: Current, voltage and resistance and their units, Ohm's law, Conductor, Semiconductor and Insulator.

Transducers: characteristics, classification of transducers-electrical, mechanical, optical. Applications in chemical and biological instruments.

Magnetism **[5]**

The magnetic field, The definition of B, magnetic dipoles, Units of magnetism, Electromagnetic induction, Faraday's law, Lenz's law.

Basic Electronics **[16]**

Voltage and current sources, Inductance coils, capacitors and transformers. Rectifiers and voltage regulators: Volt-ampere characteristics of Junction diode, Half wave, Full wave and Bridge rectifiers using Junction diodes, Percentage regulation, Ripple factor and Rectification efficiency. ripple filters, Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation. Junction Transistor and its characteristics in CE mode, Current gain, Voltage gain, Light Emitting Diodes, Photoiodes and Phototransistors.

Text Books & References

1. Haliday, Resnik and Walker, Fundamentals of Physics, 10e, John Wiley and Sons.
2. Elements of Properties of Matter, by D. S. Mathur, S. Chand and Sons, (2013).
3. Text book of Sound by D.R. Khanna and R.S. Bedi, Delhi : Atma Ram, 1962.
4. H.S. Kalsi, Electronic Instrumentation,Tata McGraw Hill Publication.
5. A course in Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons,
6. V.K.Metha, Principles of Electronics, S.Chand & Company (2009).
7. A.P.Malvino, Electronic Principles –TMH 5^{th} edition

PYG102 :OPTICS and INSTRUMENTATION

(4 credits theory paper)

Image Formation **[8]**

Luminous intensity and its units, reflection, refraction. Introduction to lenses, optical properties of lenses, thin lenses & thick lenses, cardinal points of an optical system.

Aberrations: Spherical & chromatic aberrations in lenses (only conceptual), methods of minimizing spherical & chromatic aberrations.

Eyepieces: Kellner's, Ramsden And Huygens eyepiece. Construction and image formation with optical ray diagrams.

Interference: **[3]**

Interference by division of wave front & division of amplitude. One example of each kind.

Diffraction: **[5]**

Concept of diffraction, Fresnel and Fraunhoffer class of diffraction. Concept of Fraunhoffer diffraction at single slit. Application of Fraunhoffer diffraction to resolving power of optical instruments, Raleygh's criterian for resolution, resolving power of telescope and microscope.

Polarization: **[5]**

Concept of polarization, plane of polarization, polarization by reflection, Brewster's law, polarization by refraction, double refraction. Nicol prism, simple Polarimeter.

Lasers: **[7]**

Stimulated and spontaneous emission, population inversion, Lasers, properties of Lasers, different kinds of Lasers, applications of Lasers in Medicine and Science. Optical fibers: Basic principle and applications.

X-Rays **[5]**

Coolidge tube generator, continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, wave nature of X-rays – Laue's pattern, diffraction of X-rays by crystal, Bragg's law, Bragg single crystal spectrometer, analysis of crystal structure - simple cubic crystal.

LCD And LED Displays: **[5]**

Types of liquid crystals, principle of liquid crystal displays, applications, LED's, LED displays and their advantages.

Instrumentation **[7]**

Simple microscope, compound microscope, phase cantrast microscope, electron microscope, XRD, UV and IR spectroscopy.

MEDICAL IMAGING PHYSICS: **[12]**

Magnetic field, diamagnetism, paramagnetism and ferromagnetism, X-ray diagnostics and imaging, Physics of nuclearmagnetic resonance (NMR) – NMR imaging – MRI Radiological imaging –Radiography –X-ray film – fluoroscopy –computed tomography scanner – principle function – display – generations –mammography. Ultrasound imaging – magnetic resonance imaging.

Demonstration in class/ laboratory. (Any four) **[4]**

1. Luxmeter/Photometer .
2. Construction and image formation of Ramsden /Huygens eyepiece.
3. Interference patters using Fresnel's biprism, Lloyds mirror in Physics Laboratory.
4. Fresnel and Fraunhoffer class of Diffraction, Resolving power of telescope and microscope in Physics Laboratory
5. Polarization using Polaroid, Double refraction. Nicol prism, simple polarimeter in Physics Laboratory
6. Some properties of lasers in class
7. Analysis of x-ray diffraction data for crystal structure determination

Text Books & References

1. N Subrahmayam and N.Brijlal, Text Book of Optics, S. Chand & Company Ltd,(1991).
2. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985).
3. Banwell, Fundamentals of Molecular Spectroscopy, TMH (2012).
4. K. Thyagrajan and A. Ghatak Laser: Theory and Applications, McMillan (2009).
5. R. S. Khandpur, Handbook of Biomedical Instrumentation, Second Edition. Front Cover. . Tata Mcgraw-hill Pub, 1992 Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978).

PYG103: ACOUSTICS AND NOISE CONTROL

(4 credits theory paper)

1. **Fundamentals** (12)
   Introduction to Acoustics; Brief History of Acoustics; Frequency, Wavelength, Simple harmonic motion & Superposition of waves; Sound waves; Acoustical properties; Levels; Source Characterization; Human hearing mechanisms; Pitch, Loudness, Intelligibility & Annoyance; Other Effects (Precedence Effect, Perception of Echoes and Direction, Binaural Sound).
2. **Acoustics of Rooms for Speech, Music & Worship** (16)
   Energy Build-up in a Room; Room Impulse Response; Subjective & Objective Room Acoustical Parameters for Music; Speech-Intelligibility Tests & Metrics; Rooms for Speech Intelligibility; Speech Privacy Calculations; Speech Reduction Rating & Privacy; Open-Plan Ceilings & private offices; Masking Sound; Acoustical Characterization of a Worship Space, Church Acoustics; Temple Acoustics; Mosque Acoustics; Acoustics of other Worship Spaces; Sound Reinforcement & Electro-acoustics.

3. **Ultrasonics: Biological & Medical Acoustics** (16)
   Ultrasonics (Relaxation processes, Cavitation, Phonons, Transducers, Transducers Arrays, Ultrasound Imaging); Forest & Ocean Bioacoustics (Optimized Communication; Insects; Land Vertebrates; Birds; Bats; Aquatic Animals; Generalities; Quantitative System Analysis**;** Hearing in Cetaceans; Echolocation Signals; Odontocete Acoustic Communication; Acoustic Signals of Mysticetes); Medical Acoustics (Basic Physics of Ultrasound Propagation in Tissue; Methods of Medical Ultrasound Examination; High-Intensity Focused Ultrasound (HIFU) in Surgery; Thrombolysis; Lower-Frequency Therapies) .
4. **Environmental Noise: Sources, Effects, & Control** (16)
   Environmental Noise: Characterization, Prediction, Assessment & Control (Specification & measurement of sound isolation, Design of partitions & barriers, Railroad noise, Aircraft and Airport noise, Industrial Noise, Building site noise), Noise in buildings & communities (criteria, isolation of air-borne & structure-borne noise in buildings, community noise ordinances); Effects of Noise on People (Sleep disturbance due to transportation noise exposure; Effects of infrasound, low-frequency noise & ultrasound on people; Auditory hazards of impulse & impact noise; Noise induced annoyance & stress; Effect of Noise on Behaviour & Work Efficiency; Hearing protectors; Hearing conservation programs; Rating measures, descriptors, criteria & procedures for determining human response to noise).

Text Books & References:

1. Springer Handbook of Acoustics, Rossing, 2007.

2. Architectural Acoustics, M. Long, 1st Ed., 2005.

3. The Master Handbook of Acoustics, Everest, 4th Ed., 2000.

4. Worship, Acoustics & Architecture, Cirillo & Martellotta, 2006.

5. Acoustics of Worship Spaces, Lubman & Wetherill, 1985.

6. Engineering Noise Control, C. Hansen, 4rd Ed. 2009.

7. Fundamentals of Acoustics, Bruneau, 2006.

8. The Science and Applications of Acoustics, Daniel Raichel, 2000.

9. Fundamentals of Acoustics, Kinsler et al., 4th Ed, 2000.

10. Handbook of Noise and Vibration Control - Crocker, 2007.

11. Noise and Vibration Control Engineering - Principles and Applications, Ver & Beranek, 2nd Ed. 2006.

12. Acoustical designing in Architecture, Knudsen, Harris, 1988.

PYG104: BIOPHYSICS and BIOMEDICAL INSTRUMENTATION
(4 credits theory paper)

Basic Transducer Principles **[2]**

Transducer and transduction principle, active transducer, passive transducer, transducers for biomedical applications.

Sources of Bioelectric Potentials: **[5]**

Resting and acting potentials, bio electric potentials Electrodes: Biopotential electrodes, measurement of biopotentials with two electrodes.

PHYSICS OF THE BODY-I **[15]**

Mechanics of the body: Skeleton, forces, and body stability. Muscles and the dynamics of body movement, physics of body crashing.

Energy in the body: Energy balance in the body, energy consumption of the body, heat losses of the body.

Pressure system of the body: Physics of breathing, instrumentation for measuring the mechanics of breathing, measurement of blood pressure, working principle of the manual Hg Blood Pressure monitor.

Physics of the cardiovascular system, Cardio vascular measurements: Electrcardiography.

PHYSICS OF THE BODY-II **[12]**

Acoustics of the body: Nature and characteristics of sound, Production of speech,

Physics of the ear,

Diagnostics with sound and ultrasound

Optical system of the body: Physics of the eye, Understanding the working of a manual optical eye-testing machine and to learn eye-testing procedure.

Electrical system of the body: Basic Physics of the nervous system, Electrical signals and information transfer.

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I **[7]**

X-RAYS: Electromagnetic spectrum – production of x-rays – x-ray spectra-Brehmsstrahlung-Characteristic x-ray – X-ray tubes – Coolidge tube – x-ray tube design– tube cooling stationary mode – Rotating anode x-ray tube – Tube rating – quality andintensity of X-ray.

RADIATION PHYSICS: [6]

Radiation types and units - exposure - absorbed dose – units: rad, gray -relative biological effectiveness - effective dose - inverse square law - interaction ofradiation with matter - linear attenuation coefficient. Radiation Detectors –Thimblechamber- condenser chambers – Geiger counter – Scintillation counter – ionization chamber, semiconductor detectors.

MEDICAL IMAGING PHYSICS: [11]

X-ray diagnostics and imaging, Physics of nuclearmagnetic resonance (NMR) – NMR imaging – MRI Radiological imaging –Radiography –X-ray film – fluoroscopy –computed tomography scanner – principle function – display – generations –mammography. Ultrasound imaging – magnetic resonance imaging

BASIC ELEMENTS OF NUCLEAR MEDICINE [3]

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging,

Single photon and positron emission tomography.

Test Books & References:

9. ***R. S. Khandpur,*** Handbook of ***Biomedical Instrumentation***, Second Edition. Front Cover. . Tata Mcgraw-hill Pub, 1992.
10. Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978).
11. Lessley Cromwell Biomedical Instrumentsand Measurements 3rd Ed, Peranon Education, 2004.
12. P. Narayanan, Essentials of Biophysics, New age Publisher, 2000.
13. Dr. K. Thayalan, Basic Radiological Physics - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).
14. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology , Lippincot Williams and Wilkins (1990).
15. Irving P. Herman, Physics of the human body, Springer (2007).
16. F M Khan, Physics of Radiation Therapy : - Williams and Wilkins, 3rd edition (2003).
17. Bushberg, Seibert, Leidholdt and Boone, The essential physics of Medical Imaging, Lippincot Williams and Wilkins, Second Edition (2002).

18. H. E. Johns and J. R. Cunningham, The Physics of Radiology, 1984.

Appendix C

PYS101: NETWORK ANALYSIS

(3 credits theory and one credit practical)

Review of BASIC CONCEPTS: [5]

Voltage, Current, Power and Energy, Constant voltage and constant current source, The sine wave, RMS value and average value of a sine wave, The Resistance, Inductance and Capacitance, Kirchhoff's Voltage Law, Kirchhoff's Current Law, Principle of non-inductive resistance coils, Mutual inductance, Coefficient of coupling. Self Inductance of co-axial cables, Inductance in series and parallel. Capacitances in series and parallel.

CIRCUIT ANALYSIS AND NETWORK THEOREMS: [10]

Mesh analysis, Super Mesh analysis, Nodal analysis, Super Node analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer Theorem, Impedance matching.

RESPONSE OF RL, RC and RLC circuits to DC and AC [11]

Transient Response of RL, RC and RLC circuits. Sinusoidal response of RL, RC, RLC circuits, Impedance diagram, Phase angle, series and parallel complex impedance circuits.

POWER AND POWER FACTOR: [3]

Instantaneous power, Average power, Apparent power and Power factor, Reactive power, Power triangle.

COUPLED CIRCUITS: [3]

AC applied to mutually coupled L-R circuits. Reflected impedance, Transformers, Effect of loading the secondary of a transformer, Ideal transformer.

RESONANCE: **[3]**

Series resonance, quality factor (Q) and its effect on Bandwidth, parallel resonance, Q factor of parallel resonance.

TWO-PORT NETWORK: **[7]**

Two-port networks, open circuit impedance (Z) parameters, Short circuit admittance (Y) parameter, Hybrid (h) parameter, Interrelationship of different parameters, T & II networks, Lattice networks.

AC BRIDGES **[3]**

General AC bridges, Maxwell's bridge, Maxwell's L/C bridge, De-Sauty's bridge. Wein's frequency bridge.

Text Books & References

7. Sudhakar and Shammohan, Circuits and Networks Analysis and Synthesis, TMH, (2006).
8. J. Yarwood and J. H. Fewkes, Electricity and Magnetism. University Tutorial Press (1991).
9. D. N. Vasudeva,Fundamentals of Electricity and Magnetism.S. Chand and Company Ltd. New Delhi.(2012).
10. Brijlal and Subramaniam, Electicity and Magnetism, Ratan Prakashan, New Delhi. (1966).
11. Thereja B.L. Text Book of Electrical Technology, S. Chand and Co Ltd. New Delhi (1990).
12. Mahmood Nahvi, Joseph Edminister, Electrical Circuits, Schaum outline Series, (2002).

Practical:

Minimum of 4 experiments.

1. Design of 1 mH inductor.
2. Study of High pass, Low Pass filters using passive components.
3. Band pass and Band stop filters using passive components.
4. Study of passive integrator and differentiator.
5. Thevenin’s Theorem and Norton’s Theorem.
6. Varification of Superposition Theorem.
7. Impedance Matching.
8. Response of LR, circuit to DC and AC.

9. Response of CR circuit to DC and AC.

PYS102: COMPUTATIONAL PHYSICS using FORTRAN

(3 credits theory and one credit practical)

Introduction: **[5]**

Importance of computers in Physics, paradigm for solving physics problems for solutions**.**

Installation and introduction to Linux.

Algorithms and Flowcharts: **[10]**

Algorithm: Definition, properties and development.

Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum and product of two matrices, Sum and Product of a finite series, calculation of Factorial, calculation of Sin(x), Cos(x) as a series, Integration.

Scientific Programming: **[30]**

Some fundamental Linux Commands (Internal and External commands).

Development of FORTRAN.

Basic elements of FORTRAN: Character Set, FORTRAN Constants and their types, FORTRAN Variables and their types, Keywords, Variable Declaration and concept of instruction and program.

Operators: Arithmetic, Relational, Logical and Assignment Operators.

Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions.

Fortran Statements, Layout of FORTRAN Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from Physics.

Control Statements

Types of Logic: Sequential, Selection, Repetition

Branching Statements: Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements

Looping Statements: DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops

Jumping Statements: Unconditional GOTO, Computed GOTO, Assigned GOTO

Subscripted Variables

Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays.

Functions and Subroutines

Arithmetic Statement Function, Function Subprogram and Subroutine, RETURN, CALL, COMMON and EQUIVALENCE Statements, Structure, Disk I/O Statements, Open a file, writing in a file, reading from a file. Examples from Physics.

Practical:

Minimum of 4 practical

1. Installation of Linux
2. Exercises on syntax on usage of FORTRAN
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. Numerical Integration
9. Method of Least Squares : Linear Regression for two variables
10. Solving Linear Equations
11. To find a set of prime numbers and Fibonacci series.

PYS103: COMPUTATIONAL PHYSICS using C

(3 credits theory and one credit practical)

Introduction: **[5]**

Importance of computers in Physics, paradigm for solving physics problems for solutions**.**

Installation and introduction to Linux.

Algorithms and Flowcharts: **[10]**

Algorithm: Definition, properties and development.

Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum and product of two matrices, Sum and Product of a finite series, calculation of Factorial, calculation of Sin(x), Cos(x) as a series, Integration.

Scientific Programming: **[30]**

Some fundamental Linux Commands (Internal and External commands).

Basic elements of C: The C character Set, Identifiers and Keywords, Data types, Constants, variable and Arrays, Declarations, Expressions, Statements, Symbolic Constants.

Operators and Expressions: Arithmetic Operators, Unary Operators, Relational Logical Operators, Assignment Operators, the Conditional Operators, Library Functions.

Data Input and Output: Preliminaries, Single character input and output, entering Input data, writing output data, Opening and closing data file, format statements.

Branching Statements: Preliminaries, Branching statements, Looping statements, nested control structure, switch, break, continue, go to statements.

Arrays: Defining an array, processing an array, passing arrays to functions, multidimensional arrays.

Functions: Defining functions, accessing functions, Passing arguments to a function.

Practical:

Minimum of 4 practical

1. Installation of Linux
2. Exercises on syntax on usage of C
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. To compile a frequency distribution and evaluate mean, standard deviation etc.
6. To evaluate sum of finite series and the area under a curve.
7. To find the product of two matrices
8. Numerical Integration
9. Method of Least Squares : Linear Regression for two variables
10. Solving Linear Equations
11. To find a set of prime numbers and Fibonacci series.

PYS104: DOCUMENTATION AND VISUALIZATION

(3 credits theory and one credit practical)

Scientific word processing using LaTex **[30]**

LaTeX on Windows/Linux using TeXworks

Installing LaTex on Windows/Linux, Writing basic LaTeX document using TeXworks editor. Configuring LaTeX to download missing packages.

Report Writing

Report style having chapter, section and subsection, article style having section, subsection and subsubsection. Automatic generation of table of contents. Automatic numbering of section numbers. Appendix; its appearance in report and article style exiting from LaTeX when a compilation error occurs.

Letter Writing

Letter document class, From address, Automatic generation and format of date, Starting a new line with double slash, To address, Starting a new paragraph with a blank line, itemize environment for bullet points, enumerate environment for numbered points, Closing statement, Signature, Carbon copy.

Mathematical Typesetting

$ sign to begin and end mathematical expressions, Creating alpha, beta, gamma and delta, Space being used as a terminator of symbols, Creating spaces in mathematical formulae, Difference in font of text and formula, Difference in the minus sign in text and in formula, frac command to create fractions, Subscripts and superscripts, Use of braces {} to demarcate arguments, Not equal to, greater than or equal to, less than or equal to, much less than, Right arrow, left arrow, left right arrow, up arrow, Integral sign, limits of an integral, Matrices of different rows and columns

Equations

amsmath package and align and align* environments to create equations, Matrix differential equation, aligning two equations using &, with and without intervening text, Automatic numbering of equations using align, Labeling equations with the label command, Cross referencing equation numbers through the ref command, Inserting text between two aligned equations through the intertext command, Automatic generation of equation numbers at run time allows insertion and removal of an equation from a set of equations, Labeling sections and subsections for easy and fool-proof cross referencing, Breaking an equation into more than one line, Suppression of

equation numbers in the align environment using the nonumber command, Use of backslash (\) to make braces appear as braces left[, right] and also left[. (i.e. left bracking fullstop), Blank lines in the align environment is not permissible.

Tables and Figures: Creating tables and figures in LaTeX, Inserting figures into documents.

Beamer: Creating a presentation using Beamer

Bibliography: Creating Bibliography in LaTeX

Practical [30 hours]

(All three)

1. Hands on learning of gnuplot/Qtiplot

Visualization using gnuplot or QtiPlot :

Introduction to graphical analysis and its limitations. Introduction to Gnuplot/QtiPlot. Importance of visualization of computational data, basic commands, simple plots, plotting data from a file, saving and exporting, multiple data sets per file, equations, building functions, user defined variables and functions.

2. Hands on learning of LaTex

Reproduce a given journal report which contain tables, figures, equations etc. in LaTex

3. Hands on learning of PowerPoint presentation using Beamer.

Reproduce a given presentation in Beamer.

PYS105: ELECTRICAL AND ELECTRONIC INSTRUMENTATION

(3 credits theory and one credit practical)

D.C Indicating Instruments: (6)

PMMC Galvanometer (D'Arsonval movement) - Principle, construction and working, current sensitivity, voltage sensitivity and megohm sensitivity, advantages and disadvantages, conversion of Galvanometer into Ammeter, Voltmeter and Ohmmeter (series and shunt type), Aryton shunt, Loading effect of voltmeter.

A.C Indicating Instruments: (6)

Electrodynamometer-principle, construction and working, merits and demerits, Rectifier type Instruments, thermocouple Instrument (Ammeter), electrostatic voltmeter-principle, construction and working, watt-hour meter.

D.C and A.C Bridges: (6)

Wheat stone bridge-determination of resistance, Kelvin double bridge-determination of resistance, Maxwell's L/C bridge-determination of self inductance, Wien's bridge-determination of frequency, Schering bridge-determination of capacitance.

Power Supplies: (9)

Unregulated D.C power supplies(using full wave, bridge rectifier with C and L-C filter), transistor series and shunt voltage regulators, OP-AMP series and shunt voltage regulators, voltage regulators using IC 78xx series and ICLM317, Switching regulator(step down type).

Oscilloscopes: (9)

Block diagram of basic oscilloscope, CRT, deflection sensitivity, electrostatic deflection, electrostatic focusing (explanation only –no mathematical treatment), vertical amplifier, delay line circuit, sweep generator, measurement of voltage, period, frequency and phase difference, sampling oscilloscope, Digital storage oscilloscope – block diagram and working principle.

Instrumentation Amplifiers and Signal Analyzers: (9)

Instrumentation amplifier, Electronic voltmeters - d.c voltmeter with direct coupled amplifier, a.c voltmeter using rectifiers, ramp type digital voltmeter, digital multimeter, function generator, wave analyzers- audio range wave analyzer, heterodyne wave analyzer.

Books:

1. W. D. Cooper and A. D. Helfrik Electronic Instrumentation and Measurement Techniques - PHI Publication
2. H.S. Kalsi, Electronic Instrumentation,Tata McGraw Hill Publication
3. A course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, Dhanpat Rai & Sons
4. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory - PHI Publication
5. Ramakant Gayakwad, Op-amps and Linear Integrated Circuits, Pentice Hall, 2000.

Practical:

Minimum of 4 practical

1. Use of Analog and Digital Multimeter for components testing and measurements(voltage, current and resistance)
2. Design and construction of multi range Voltmeter
3. Design and construction of series type Ohmmeter
4. Study of Maxwell's L/C bridge for determination of inductance
5. Study of Schering bridge for determination of capacitance
6. Design and construction of Wien bridge oscillator using OP-AMP
7. Design and construction of Instrumentation amplifier using OP-AMP
8. Series voltage regulator using transistor/OP-AMP.
9. Shunt voltage regulator using transistor/OP-AMP.
10. Design and construction of Function Generator using IC XR2206.
11. Measurement of frequency and phase on a CRO using Lissajous figures
12. Study of SMPS.

PYS106-MICROPROCESSOR ARCHITECTURE AND PROGRAMMING

(3 credits theory and one credit practical)

1. Basics of Digital Electronics (8)

Number Systems: Binary and hexadecimal number system. Conversion: binary↔decimal, binary↔hexadecimal. Positive, negative logic and tri state. Binary addition. 1's and 2's complement number. 2's complement addition and subtraction. Logic gates: AND, OR, NOT, NOR,NAND, XOR. Half adder and full adder. RS FF, D FF, JK FF, T FF, Shift registers(shift left and shift right), Ripple counters, MOD 2, MOD 5 and MOD 10 counter. Memories: RAM, ROM, PROM, EPROM. Buses: address, data and control bus, Example of a simple microprogram illustrating the use of CONTROL WORD for data storage in memory and fetch from memory.

2. Introduction to microprocessor: (4)

Block diagram of a microprocessor based system and its description,memory (Gaonkar 2.1 – 2.4)

3. 8085 Microprocessor Architecture: (7)

8085 pin configuration & function of each pin. Buses and its organization, registers, flags, Instruction Format, Fetch, decode and execute operations. Op -code Fetch, execute cycle, T state, Machine cycle. Memory and I/O read and write cycles. Examples for Timing diagram for MOV and MVI instruction. (Gaonkar 3.1 – 3.3)

4. Interfacing I/O Devices: (5)

IN and OUT instruction(no timing diagram), Device selection and data transfer, interfacing o/p displays, Memory mapped I/O(no timing diagram) (Gaonkar 4.1-4.4)

5. Introduction to 8085 Assembly Language Programming (8)

8085 programming model, instruction classification, instruction format, writting, assembling and executing a simple program, overview of 8085 instruction set, Data transfer operations, arithmetic operations, logic operations, branch operations, (Gaonkar 5.1- 5.5 ,6.1-6.4)

6. Advanced 8085 Programming: (5)

Looping, counting and indexing, Additional data transfer and 16 bit arithmetic instruction, Arithmetic operations related to memory, logic rotate instructions, compare instructions. (Gaonkar 7.1-7.5)

7. Time Delays (4)

Counters and time delays, Programs: hexadecimal counter, Mod 10 counter (Gaonkar 8.1-8.3)

8. Stack and Subroutines: (4)

stack, subroutine, conditional call and return instructions. (Gaonkar 9.1-9.3)

Books:

1. Malvino and Leach, Digital Principles and Applications, TMH (1986).

2. R. P. Jain, Modern Digital Electronics, TMH (2003).

3. Ramesh S Gaonkar - Microprocessor Architecture, Programming and application with 8085, 4th Edition, Penram International Publishing, New Delhi

4. Microprocessor 8085 and its Interfacing, By Sunil Mathur, Second Edition, PHI Learning Pvt. Ltd.

5. 0000 to 8085 Introduction to Microprocessors for Engineers and Scientists by P.K. Ghosh, P.R. Sridhar Prentice Hall India.

Practicals: (programs can be on 8085 kit or using 8085 simulation software)

Minimum of four practical

1. Addition of one byte numbers
2. Addition of 2 byte numbers with ADC
3. Addition of 2 byte numbers with DAD instruction
4. Subtraction using 2's complement subtraction
5. Block transfer of data
6. Multiplication of two one byte numbers using rotate instruction
7. Multiplication of two one byte numbers using repetitive addition
8. Division of two 16 bit numbers
9. Division of two 2 byte numbers
10. Multi byte BCD addition
11. conversion of hexadecimal to decimal numbers
12. sorting number in ascending and descending order
13. Finding the greatest or least of a group of numbers

PYS107-MICROCONTROLLER ARCHITECTURE AND PROGRAMMING

(3 credits theory and one credit practical)

1. Introduction: (2)

Microprocessors and Microcontrollers, microcontroller types.

2. 8051 Architecture: (8)

Hardware, I/O pins, ports and circuits, memories, counters and timers, serial data I/O, interrupts.

3. 8051 Instruction set: (10)

Addressing modes, data movement, Instruction- external data move, code memory read-only-data moves, push and pop opcodes, data exchanges, programs.

4. Logical operations: (4)

bit and byte level, rotate and swap, jump instructions, call and return instructions, programs.

5. Arithmetic operations: (5)

Flags, incrementing, decrementing, addition, subtraction, multiplication, division, interrupt priority in 8051.

6. Interrupt programming: (8)

8051 interrupts, programming timer interrupts, external hardware interrupts, interrupt priority in 8051.

7. Interfacing 8051 & programming: (6)

LED, 7 segment display, LCD, keyboard, stepper motor, DAC and ADC.

8. Embedded system software tools: (2)

IDE, simulators, debuggers, compilers and cross compilers, software monitors, watch dog timers

(basic working only- no programs).

Books:

1. Muhammad Ali Mazidi & Janice Mazidi – The 8051 microcontroller and Embedded systems – Pearson Education.

2. Kenneth J Ayala – The 8051 Microcontroller, Architecture, Programming & applications - 2nd edition – Penram international.

3. David Simon – An Embedded Software Primer - Pearson Education.

4. Myke Predco – Programming and customizing 8051 microcontroller.

Practical: (use kit or simulation software and programming in assembly or C/C++)

Minimum of four practical

1. Programs to illustrate the types of Addressing Modes: Immediate, Direct, Register, Indirect, External, Stack, Data Exchanges – At least 3 programs

(a) Write a program to copy the value 55H (use any other value) into RAM memory locations 40H to 41H (use any other value) using (i) direct addressing mode, (ii) register indirect addressing mode without a loop, and (iii) with a loop,

Any other example programs

2. Data Transfer Programs: at least 3 programs

(a) Write a program to clear 16 RAM locations starting at RAM address 60H (Data transfer program)

(b) Write a program to copy a block of 10 bytes of data from 35H to 60H

Any other example programs

3. Port programming: At least 3 programs

(a) Write a program to get the x value from P1 and send x2 to P2, continuously

Any other example programs

4. Timer programming: At least 3 programs

(a) Copy a byte from TCON register using at least 4 different methods

(b) Setting timer T0 to 1234H using direct and indirect addressing

Any other example programs

5. Logical operations: at least 3 programs

6. Serial data transfer programs: at least 2 programs

7. Programs to perform arithmetic operations (including BCD addition) with data in internal/external RAMs and use of Register Banks. - at least 3 programs

8. Programs to illustrate loop, jump and call instructions. - at least 3 programs

9. Programs to illustrate Timer Interrupts and External Interrupts (with wavefrom generation). - at least 3 programs

10. Interface LCD to 8051 and display messages.

11 Interface Keypad to 8051 and program to accept the key input and display it on LCD.

12. Interface LEDs and 7-segment displays to 8051 and program to activate the devices.

13. program to illustrate traffic lights

14. Program to illustrate ADC / DAC conversion

PYS108-PHOTOGRAPHY

(3 credits theory and one credit practical)

1. Introduction to photography [3]
   Definition of photography, Physics of photography, History and developments in photography, Types of photography, Digital photography.
2. Camera Basics [3]
   Types of cameras, introduction to common brands of cameras, Camera Controls, basic camera settings, Basic camera operations.
3. DSLR Camera [3]
   Detailed operational procedure of a DSLR Camera and shooting modes
4. Exposure [2]
5. Aperture & Shutter Speeds [2]
6. ISO, Exposure compensation, Concept of high- and low key photographs [3]
7. Light Meter, TTL concept [2]
8. Depth of Field [3]
9. White balance and colour compensation [3]
10. Lenses [4]
    Importance of lens in a camera, focal length of camera lenses and its effects on photographs. Types of lenses. (Prime lens, zoom lens & tilt lens) Categorization of lenses (kit lenses, micro, macro, wide angle & telephoto lenses).
11. Lighting [4]
    Natural lighting, artificial lighting. speed lights, studio strobes, light modifiers, colour gels.
12. Effect of lighting on photographs [4]
    Fill light, back light, Rembrandt lighting; butterfly lighting, golden hour and sun set photography
13. Flash Photography [3]
    TTL, high speed sink, Composition tips and Shooting at Night
14. Filters, Tripod, & Camera Accessories [3]
15. Introduction to a photo editing soft ware (adobe light room) [3]

References

1. Scott Kelby's Digital Photography Boxed Set, Volumes 1, 2, and 3 1st Edition
   Author: Scott Kelby, Publisher: Peachpit Press ©2007, 2009
2. Understanding Exposure, 3rd Edition: How to Shoot Great Photographs with Any Camera
   Author: Bryan Peterson, Publisher: Random House India Edition: 3rd Edition, 2010

3. The Photographer's Eye: Composition and Design for Better Digital Photos 1st Edition
   Author: Michael Freeman, Publisher: Focal Press; 1st edition (May 23, 2007);
4. Extraordinary Everyday Photography: Awaken Your Vision to Create Stunning Images Wherever You Are
   Author: Brenda Tharp, Publisher Amphoto books 2012
5. Better Photo Basics: The Absolute Beginner's Guide to Taking Photos Like a Pro 1st Edition
   Author: Jim Miotke, Publisher: Amphoto Books 2010
6. The Art of Photography: An Approach to Personal Expression
   Author: Bruce Barnbaum, Publisher: Photographic Arts Editions in cooperation with Rocky Nook Inc 2010
7. David Busch's Mastering Digital SLR Photography (David Busch's Digital Photography Guides) 3rd Edition
   Author: David D. Busch, Publisher: course technology PTR 2012
8. Basic 35mm Photo Guide: For Beginning Photographers 5th Edition
   Author: Craig Alesse, Publisher: Amherat Media Inc. 2001
9. How to Photograph Absolutely Everything: Successful Pictures From Your Digital Camera
   Author: Tom Ang, Publisher: DK; Reprint edition 2009
10. 50 Photo Projects - Ideas to Kickstart Your Photography
    Author: Lee Frost, Publisher: David & Charles; 2009

Practical (All the following) (One Credit)

1. Photograph a subject of interest using different shooting modes to see how that affects the images. Bring 10 images on external media (flash or hard drive).
2. Practice exposure compensation with the camera. Bring 10 high and low-key images on external media (flash or hard drive).
3. Practice shooting portraits and try different lighting techniques. Bring 10 portraits on external media (flash or hard drive).
4. Experiment with night photography and low light shooting. Create 5 best photographs in each category on external media (flash or hard drive).
5. Find a subject of your choice and spend time working with the subject. Practice rules of composition. Bring 10 (5 night or low light) images you are proud of on an external media (flash or hard drive).
6. Shoot 4-8 images that are conceptually driven, based on your own interests or inspired by the lecture. Bring it on external media (flash or hard drive).

7. Practice photo editing and enhance the best 10 images of your choice. Bring it on external media (flash or hard drive).
8. Print the best 10 photographs and present it at the photo exhibition arranged in college at the end of semester.