St. Xavier's College – Autonomous
Mumbai

Syllabus
For 5th Semester Courses in PHYSICS
(June 2015 onwards)

Contents:

T.Y. B.Sc. PHYSICS **Course: S. PHY. 5.01**

Title: Classical Mechanics

Number of lectures: 60

Learning objective: To understand physical phenomena of mechanical systems

UNIT-I **(15 LECTURES)**

1. Motion under a central force. The central force inversely proportional to the square of the distance. Parabolic orbits, Elliptical orbits. The Kepler problem. Hyperbolic Orbits: The Rutherford problem- Scattering cross section.
2. Newton's laws in non inertial frames-Moving origin of co-ordinates, Rotating co-ordinate systems, Laws of motion on the rotating earth, Foucault pendulum, Larmor theorem.

UNIT- II **(15 LECTURES)**

Lagrange's equations: Generalized coordinates, Lagrange's equations, examples, Systems subject to constraints, examples of system subject to constraints, constants of motion and ignorable coordinates.

UNIT- III **(15 LECTURES)**

The rotation of a rigid body: Motion of a rigid body in space, Euler's equations of motion for a rigid body, Euler's angles, Heavy symmetrical top (without nutation).

UNIT- IV **(15 LECTURES)**

1. Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow.
2. Non linear mechanics: Qualitative approach to chaos, The anharmonic oscillator, Numerical solution of Duffing's equation, Transition to chaos: Bifurcations and strange attractors, Aspects of chaotic behavior.

References:

1. Mechanics - Keith Simon
2. Classical Mechanics - Herbert Goldstein
3. Classical Mechanics - Takawale & Puranik
4. Classical Mechanics - Adarsh Shroff
5. Mechanics - Barkely Physics course vol.I- – Kittel, Knight & Ruderman.
6. Fluid mechanics - Raymond.
7. Non-Linear dynamics & chaos - Persiwal & Richards.

CIA: **Problem solving/ assignments**

T.Y.B.Sc Physics **COURSE:S.PHY.5.02**

Title: Mathematical Physics
Number of Lectures: 60
Learning Objective: To understand the mathematical concepts related to physics

UNIT-I **(15 LECTURES)**

1. **Matrices**:. Basic definitions of Matrices, Equality and Rank, Matrix Multiplication, Inner product, Dirac bra-ket, Transposition, Multiplication (by a scalar), Addition, Product theorem, Direct product, Diagonal matrices, Trace, Matrix inversion. Orthogonal Matrices: Direction cosines, applications to vectors, orthogonality conditions : Two dimensional case, Euler angles, symmetry properties and similarity transformations, Hermitian Matrices and unitary matrices: Definitions, pauli matrices**.** Diagonalisation of matrices**:** Moment of inertia matrix, Eigen vectors and Eigen values, Hermitian matrices, anti-hermitian matrices, normal modes of vibrations, Ill conditioned systems, Functions of matrices.
2. **Functions of a complex variable I:** Complex Conjugation, Functions of a Complex Variable, Cauchy-Riemann Conditions, Analytic Functions. Cauchy's Integral Theorem: Contour Integrals, Stokes's Theorem Proof of Cauchy's Integral Theorem, Multiply connected regions. Cauchy's Integral Formula: Derivatives, Morera's Theorem. Mapping: Translation, Rotation, Inversion, Branch Points and Multivalent Functions, Conformal Mapping.

UNIT-II **(15 LECTURES)**

1. **Functions of a complex variable II:** Laurent Expansion: Taylor Expansion, Schwarz Reflection Principle, Analytic Continuation, Laurent series. Singularities**,** Poles, Branch Points**,** Calculus of Residues: Residue Theorem, Evaluation of definite integrals, Cauchy Principle value.
2. **Differential Equations:** Review of first order ODEs, Second Order ODEs: Inhomogeneous Linear ODEs and particular solutions, Inhomogeneous Euler ODE, Inhomogeneous ODE with constant coefficients, Linear Independence of Solutions.

UNIT-III **(15 LECTURES)**

1. **Fourier Series and Transforms:** Review of Fourier series, Complex Fourier Series, Abel's Theorem, Properties of Fourier Series, Convergence, Integration, Differentiation.
2. **Integral Transforms**: Definitions and Linearity. Fourier Transforms,

Development of the Inverse Fourier Transform**,** Inverse Fourier-Transform Exponential Form, Dirac Delta Function Derivation from Fourier transform. Laplace Transforms, inverse Laplace transforms, solving differential equations using Laplace transforms.

UNIT-IV **(15 LECTURES)**

1. **Legendre Polynomials :** Physical Basis, power series, differential equations, Generating function, Recurrence relations, upper and lower bounds for Pn(cosΘ)**,** Orthogonality**,** applications to electrostatics.
2. **Bessel Functions of the first kind, Jn(x):**, Bessel's Differential Equations, Generating Function for Integral Order, Recurrence Relations and its applications. Integral Representations, Orthogonality, Normalization.

Main Reference: - Mathematical Physics - H.K. Dass..
Additional Ref:

1. Introduction to Mathematical Physics - Charlie Harper.
2. Mathematical Physics - A. K. Ghatak
3. Mathematical Physics - Arfken & Weber
4. Complex Variables- M.Spiegel, Schaum series
5. Laplace's Transforms- M.Spiegel, Schaum series

CIA: **Problem solving/ assignments**

T. Y. B.Sc: Physics **COURSE:S.PHY.5.03**

Title: Electronics

Number of lectures: 60

Learning objective: To understand the technology of different electronic devices

UNIT-I **(15 LECTURES)**

1. **Transistor multivibrators:** Astable, Monostable and Bistable Multivibrators, Schmitt trigger.
2. **555 Timer:** Block diagram, Astble operation (with VCO)
   Self Study: Monostable and Triggered linear ramp generator.
3. **Field effect transistor:** JFET: Basic ideas, Drain Curve, The transconductance curve, Biasing in the ohmic and the active regions, calculation of transconductance, common source amplifier, analog switch multiplexer, voltage controlled resistor, Current sourcing. MOSFET : Depletion and enhancement mode, operation and characteristics, digital switching. CMOS-Introduction.

UNIT-II **(15 LECTURES)**

1. **Differential Amplifier using transistors:** The differential Amplifier, DC and AC analysis of a differential Amplifier, Input characteristics, effect of bias and offset current and voltage on output, comman mode gain, CMRR, current mirror modification for improvement of parameters, Transistorised circuit of 741 OPAMP IC.
2. **Op Amp applications:** Comparator, Schmitt trigger, Integrator, Differentiator, Log amplifier, square wave generator, active filters.

UNIT-III **(15 LECTURES)**

1. Thyristors: SCR-Working, Equivalent circuit, important terms, I-V Characteristics, SCR as a switch, Half wave rectifier and Full wave rectifier.
2. **Optoelectronic Devices :** Photoresistance (LED, LDR), Photo-diode, Photo transistor, Optocoupler.
3. **Logic families :** Standard TTL NAND, TTL NOR, Open collector gates, Three state TTL devices, MOS inverters, , CMOS characterictics, CMOS NAND and NOR gates.
4. Self Study: DIAC , TRIAC and their applications.

UNIT-IV **(15 LECTURES)**

1. **Electronic communication techniques :**Radio broadcasting, Transmission and reception, Modulation, Amplitude modulation, Modulation factor, Analysis of amplitude modulated wave, Side band frequencies in AM wave, Transistorised amplitude modulator, Power in AM wave, Limitations of AM, Frequency modulation (qualitative), Pulse modulation (qualitative), Digital Modulation (qualitative).
2. **Optical communication:** principle and application of of fiber optics.

References :

1. Electronics Principles.- A.P. Malvino and D.J. Bates
2. Digital Principles and Applications(4th ed.) - Malvino and Leach
3. Electronic communication systems-Kennedy
4. Functional Electronics. - K.V. Ramanan
5. Integrated Electronics - Millman and Halkias
6. Roddy and Collen
7. Principles of Electronics - V. K. Mehta and Rohit Mehta.

CIA: **Problem solving/ assignments**

T.Y.B.Sc.: Physics **COURSE:S.PHY.5.04**
Title: Electrodynamics
Number of Lectures: 60

Learning objectives: To understand the fundamentals and applications of classical electrodynamics

UNIT-I **(15 LECTURES)**

1. Laplace's equation in one, two and three dimensions. Boundary conditions and Uniqueness theorems (without proof), conductors. The classic image problem, Induced surface charge, force and energy.
2. Dielectrics, Induced Dipoles, Alignment of polar molecules, Polarization, Bound charges and their physical interpretation, Gauss' law in presence of dielectrics. A deceptive parallel, Susceptibility, Permittivity, Dielectric constant, Energy in dielectric systems.

UNIT-II **(15 LECTURES)**

1. Diamagnets, Paramagnets and Ferromagnets, Magnetization, Bound currents and their physical Interpretation, Ampere's law in magnetized material's, A deceptive parallel, Magnetic susceptibilityand permeability.
2. Energy in magnetic fields, Electrodynamics before Maxwell, Maxwells correction to Ampere's law, Maxwell's equations, Magnetic charge, Maxwell's equations in matter , Boundary conditions.

UNIT-III **(15 LECTURES)**

1. The continuity equation, Poynting's Theorem , Newton's third law in Electrodynamics.
2. The wave equation for **E** and **B**, Monochromatic Plane waves, Energy and Momentum in electromagnetic waves, Propagation in linear media, Reflection and transmission of em waves at normal and oblique incidence.

UNIT-IV **(15 LECTURES)**

1. Relativity and electrodynamics
2. Electromagnetic waves in conductors, Reflections at a conducting surface, The frequency dependence of permitivity, wave guides.
3. Potentials and Fields: The potential formulation, Scaler and vector potentials, Gauge transformations, Coulomb gauge and Lorentz gauge.

References:

1) Introduction to Electrodynamics - A.Z. Capria and P.V. Panat
2) Engineering Electrodynamics - William Hayt Jr. & John H. Buck
3) Electricity and Magnetism - Navina Wadhwani
4) Feynman lectures, vol II – Lorrain and Corson
5) Berkely Physics Vol II, Electricity and Magnetism – Purcell
6) Introduction to Electrodynamics 3rd Edition - David J. Griffiths

CIA- Problem Solving / assignments

Practicals

T.Y.B.Sc. Physics **Course: S.PHY.5.PR**

Minimum four experiments to be performed from each group

Group I: Mechanics and optics

1. Determination of 'g' by Kater's Pendulum
2. Measurement of surface tension of mercury by Quincke's method
3. Flat spiral spring: Determination of Y, η, and σ
4. Resolving power of prism with the skill of optical levelling
5. Biprism

Group II: Electricity and Magnetism

1. Determination of Mutual inductance using moving coil galvanometer
2. Hysteresis using magnetometer
3. Maxwell's bridge
4. FET characteristics and its use as VVR
5. SCR characteristics

Group III: Electronics

1. Transistorised Astable multivibrator with the skill of circuit designing
2. Astable multivibrator using OPAMP with the skill of using Bread Board
3. Transistorised Bistable multivibrator or Schmitt trigger
4. 555 timer: Astable mode and VCO using AC signal with the skill of soldering
5. To Fourier analyse a Square/Triangular waveform

Group IV: Project

One project equivalent to 10 lab turns

References:

1. Advanced course in practical physics – D. Chattopadhyay, P.C. Rakshit& B. Saha
2. B. Sc. Practical physics – Harnam Singh
3. B. Sc. Practical physics – C. L. Arora
4. Practical physics – C. L. Squires
5. University Practical physics – D. C. Tayal

T.Y. B.Sc. PHYSICS **Course: S. PHY.DIP. AC. 5**

Title: Digital Image Processing-I

Number of lectures: 60

Learning objective: To study the mathematical modeling of digital images

UNIT I **(15 LECTURES)**

Introduction,

What Is Digital Image Processing?
The Origins of Digital Image Processing
Gamma-Ray Imaging
X-Ray Imaging
Imaging in the Ultraviolet Band
Imaging in the Visible and Infrared Bands
Imaging in the Microwave Band
Imaging in the Radio Band
Examples in which Other Imaging Modalities Are Used
Fundamental Steps in Digital Image Processing
Components of an Image Processing System
Problems

Digital image fundamentals

Elements of Visual Perception
Light and the Electromagnetic Spectrum
Image Sensing and Acquisition
Image Sampling and Quantization
Some Basic Relationships between Pixels
An Introduction to the Mathematical Tools Used in Digital Image Processing
Problems

UNIT II **(15 LECTURES)**

Image enhancements in spatial domain

Background
Some Basic Intensity Transformation Functions
Histogram Processing
Smoothing Spatial Filters
Sharpening Spatial Filters
Combining Spatial Enhancement Methods
Problems

UNIT III **(15 LECTURES)**

Image enhancements in frequency domain

Background
Preliminary Concepts
Sampling and the Fourier Transform of Sampled Functions
The Discrete Fourier Transform (DFT) of One Variable
Extension to Functions of Two Variables
Some Properties of the 2-D Discrete Fourier Transform
The Basics of Filtering in the Frequency Domain
Image Smoothing Using Frequency Domain Filters
Image Sharpening Using Frequency Domain Filters
Selective Filtering
Implementation
Problems

UNIT –IV **(15 LECTURES)**

Image restoration

Image Restoration and Reconstruction
A Model of the Image Degradation/Restoration Process
Noise Models
Spatial and Frequency Properties of Noise
Some Important Noise Probability Density Functions
Periodic Noise
Estimation of Noise Parameters
Restoration in the Presence of Noise Only-Spatial Filtering
Mean Filters
Order-Statistic Filters
Adaptive Filters
Periodic Noise Reduction by Frequency Domain Filtering
Linear, Position-Invariant Degradations
Estimating the Degradation Function
Inverse Filtering
Minimum Mean Square Error (Wiener) Filtering
Constrained Least Squares Filtering
Geometric Mean Filter
Image Reconstruction from Projections
Problems

Reference:
1. Digital image processing, third edition
-Gonzalez and woods
2. . Digital image processing, third edition
-A. K. Jain
3. . Digital image processing using MATLAB
-Gonzalez and woods

Practicals

T.Y.BSc Digital Image processing-I **COURSE: S.PHY.DIP.AC.5.PR**

Digital processing of given images using software
Tutorials on image processing