St. Xavier's College (Autonomous), Ahmedabad-380009

M.Sc. Physics Syllabus

Semester-2

CORE Paper. Digital Electronics and Microprocessor
Course Code: PPH-2801
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Understand 1-bit memory element, learn truth table, excitation table and FSM of different type of flip-flop.
2. Design/convert the flip-flop.
3. Learn application of flip flop as a shift register.
4. Understand working of SISO, SIPO, PIPO and PISO registers.
5. Get information about 555 timer IC.
6. Designing the different type of multivibrator using 555 IC.
7. Study different types of digital counter in detail. Also learn the synchronous and asynchronous counters
8. Study various types of digital to analog converters and analog to digital converters.
9. Study basic working and functioning of microprocessor 8085, with its organization and architecture.
10. Also perform some of the basic programming of microprocessor with additional instruction sets.

Course Structure

Unit-1

555- Timer: Description of functional diagram, Monostable operation, Astable operation, Bistable operation, Schmitt trigger circuit

Sequential logic circuits: Flip- Flops: 1- bit memory cell using transistor, 1- bit memory cell using NOR gates, clocked SR flip flop, clocked 5-R flip flop with preset and clear inputs, J-K flip flop, Race around condition, Master slave flip flop, D- flip flop, T- flip flop, characteristics equation of flip flop, Flip flop as finite state machine, flip flop excitation table, Flip flop conversion (S-R to T, D and J-K flip flop, T to D flip flop, D to T flip flop)

Registers and Shift registers: Registers, STSO shift register, SIPO shift registers, PISO shift registers, PIPO shift registers, Bidirectional shift registers, Universal registers

Unit-2

Counters: Asynchronous counter, Ripple counter, Decoding gates, Synchronous counter, Mode -3 counter, Mode-5 counter, Mode-10 counter, Synchronous counter design, Design of UP- down counter, Analysis of clocked sequential circuit, State table, state diagram, Design of state sequential circuit

AID and *DIA* converter: Basic principle of DAC, DAC circuits, Resister divider DAC, R/2R ladder network DAC, DAC specification, Basic principle of AOC, AOC circuits, Parallel comparator AOC, Counter type AOC, Successive approximation type ADC, Dual slope ADC, Specification of ADC

Unit-3

Microprocessors and its Architecture: Microprocessors, Microprocessor as a CPU, Organization of a Microprocessor based system, working of a Microprocessor, Languages employed in a Microprocessor, 8085 MPU and its architecture, Microprocessor Communication and Bus Timings.

Unit-4

Microprocessor Programming: Introduction to 8085 MPU Instructions, 8085 MPU programming with additional instructions.

Reference Books

1. Linear Integrated circuit 4th edition, By Roy Choudhury and Jain, New Age International
2. Digital Electronics By G K Kharate, Oxford university Press
3. Digital Principles and Applications By Malvino, Leach and Saha
4. Digital Design By Morris Mano
5. Microprocessor Architecture, Programming, and Applications with the 8085, sixth edition, Ramesh Gaonkar, Penram lnternational Publications.

6. Microprocessor Programing and Interfacing by .K. Srinath; PHT publications.

7. Microprocessor and its interfacing by Sunil Mathur, PHT publications.

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M.Sc. Physics Syllabus

Semester-2

CORE Paper: Electrodynamics
Course Code: PPH-2802
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Understand different conservation laws.
2. Solve problems of electromagnetic waves and wave propagation.
3. Describe the nature of electromagnetic wave and its propagation through different media and interfaces.
4. This unit is aims to teach advance formulation of retarded scalar and vector potentials for generalized description of electromagnetic fields originating from moving and accelerating point charges.
5. Understand the concept of dipole radiation and its application to design and optimize the antenna properties.
6. Describe the concept of electromagnetic waves radiation for electric and magnetic dipole moment.
7. Understand the relativity concepts of electrodynamics, and discussion of Lienard Wiechert potential.
8. Understand and analyse the electrical quadruple and amount of total power radiation transmitted for different cases like arbitrary source and point charges.
9. This unit introduces students with concept of scattering of electromagnetic waves by dipoles, dielectric spheres and many other media with applications.
10. Understand the scattering and dispersion in detail and perturbation theory of scattering.
11. Solve the problems of the above-mentioned concepts and theory

Course Structure

Unit-1

Conservation **Laws:** Charge and Energy, The continuity equation, Poynnting's theorem, momentum, Newton's third law in electrodynamics, Maxwell Stress Tensor, Conservation of Momentum, Angular momentum, problems, Electromagnetic ¼raves and wave propagation; Wave guides Absorption and Dispersion, Electromagnetic waves in conductors, Reflection at a Conducting surface, The frequency dependence of Permittivity, Guided waves, Wave guides, The TE waves in a rectangular Wave Guide, Resonant cavities, Cavity resonator - Faraday and Kerr effects. The Coaxial Transmission Line. Problems

Unit-2

Potential and Fields: The Potential formulation, Scalar and Vector Potential, Gauge Transformation, Coulomb Gauge and Lorentz Gauge, Continuous distributions, Retarded Potentials, Jefimenko Equations, Point charges, Lienard -Wiechert Potentials, The fields of a Moving Point Charge, Total power radiated by an accelerated charge: Larmour's formula and its relativistic generalization, Problems

Unit-3

Radiation: What is Radiation? Electric dipole radiation, Magnetic dipole radiation, Electric Quadrupole fields, Center fed Linear Antenna , Approximation of Sinusoidal current,, The Antenna as a Boundary value problem, Radiation from arbitrary source, Point charges, Power radiated by a point charges, radiation reaction, Abraham- Lorentz formula for radiation reaction, The Physical basis of radiation Reaction. Problems

Unit-4

Scattering and Dispersion: Scattering at long wavelengths, scattering by dipoles induced in a small scatterers, scattering by a small dielectric sphere, scattering by a perfectly conducting sphere, collection of scatterers, Perturbation theory of Scattering, Rayleigh's explanation of the blue sky, scattering by gas and liquids, attenuation in optical fiber: General theory, Born approximation, Blue sky, Density fluctuations: Critical Opalescence, Attenuation in optical fiber, Dispersion in Dilute gases, Dispersion in liquids and solids, Media containing free electrons, Problems

Reference Books

1. Griffiths, introduction to electrodynamics, Prentice Hall lndia Ltd. (2nd ed.)
2. Classical Electrodynamics John David Jackson(Third Edition) Wiley Student edition.
3. Laud 8. B., Electromagnetics, Wiley Eastern, (2nd ed.)

4. J.R. Reitz, F.J. Milford and R.W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd Edition, Narosa Publication, ew Delhi.

5. W. Panofsky and M. Phillips, 1962, Classical Electricity and Magnetism, Addison Wesley, London. 2.

6. J.D. Kraus and D.A. Fleisch, 1999, Electromagnetic with Applications, 5th Edition WCB McGraw-Hill, New York.

7. 8. Chakraborty, 2002, Principles of Electrodynantics, Books and Allied, Kolkata.

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M.Sc. Physics Syllabus

Semester-2

CORE Paper. Classical Mechanics and Computational Physics
Course Code: PPH-2803
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. To demonstrate knowledge and understanding of the fundamental concepts in Lagrangian and Hamiltonian formulation of mechanics
2. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics.
3. To be familiar with the foundations of Theoretical Physics.
4. Understand Python programming language, solve physics problems using Python
5. Understand Mathematica Software
6. Solve physics problems using Mathematica Software

Course Structure

Unit-1

Canonical Transformation: An overview of Langrangian and Hamiltonian formulation, Noether's Theorem, Conservation Principles and Homogeneity of Space and Time. Canonical transformations: Generating functions, examples of canonical transformations, Poisson brackets and the Symplectic Condition, conservation theorem in Poisson bracket formalism, Jacobi's identity, angular momentum Poisson bracket relations.

Unit-2

Hamilton Jacobi Theory: Hamilton-Jacobi theory: Hamilton-Jacobi equations for principal and characteristic functions, Harmonic oscillator problem, Central force problem, Action-angle variables for systems with one-degree of freedom.
Small Oscillation: Eigen value equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule.

Unit-3

Numerical Methods using Python & Mathematica: Introduction to Python, Systems of Linear Algebraic Equations, Interpolation, Curve Fitting, Roots of Equations, Numerical Differentiation, Numerical Integration, Initial Value Problems, Matrix Algebra, Introduction to Mathematica and solving numerical methods.

Unit-4

Physics with Python & Mathematica : Classical Mechanics, Newtonian Mechanics, Central Forces, Calculus of Variation, Lagrange Dynamics, Hamiltonian Dynamics. Quantum Mechanics: The Schrodinger Equation, One- Dimensional Potential, The Harmonic Oscillator, Anharmonic Oscillator, Motion in the Central Force Field.

Reference Books

1. Classical Mechanics, H Goldstein, Pearson
2. Classical Mechanics, Rana & Joag, TMH
3. Mechanics, L D Landau E M Lifshitz, Elsevier Science Publications
4. Classical Mechanics, A *K* Raychaudhuri, Oxford University Press
5. Learning Python: Powerful Object-Oriented Programming, by Mark Lutz,0 Reilly publication (5th Edition)
6. Numerical methods in Engineering with Python, by Jaan Kiusalaas, Cambridge University Press
7. The Mathematica Book by Stephen Wolfram, Cambridge University Press
8. Mathematica for Theoretical PhysicsVol - 1 and 2, Gred Baumann, Springer (2nd Edition)

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M.Sc. Physics Syllabus

Semester-2

CORE Paper. Quantum Mechanics-II, NMR, and LASERS
Course Code: PPH-2804
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Describe Symmetry transformation and conservation law, explain translation in space and time; deduce conservation of linear momentum and conservation of energy.
2. Discuss rotation in space and obtain conservation of angular momentum, identify space inversion: parity conservation.
3. Obtain eigen value of the square of the angular momentum operator and z component of angular momentum operator.
4. Derive the angular momentum matrices, state Pauli's spin matrix and derive spin matrix of a spin (1/2) system
5. Describe addition of angular momenta and obtain Clebsh-Cordan coefficient for a given system having two angular momenta
6. About fundamental of Nuclear Magnetic Resonance, measurement of MR spectra and its interpretation, hardware, experimental methods, equivalent theoretical description and its applications like NMRT in daily life.
7. Describe the requirements for a system to act as a laser.
8. Differentiate the various types of lasers and their means of excitation, relate the structure and properties of lasers to their performance and intended applications

Course Structure

Unit-1

Symmetry and Conservation **laws:** Symmetry Transformation, Translation in Space: Conservation of Linear Momentum, Translation in lime: Conservation of Energy, Rotation in Space; Conservation of Angular momentum, Space Inversion; Parity Conservation, Time Reversal

Unit-2

Angular momentum: General Angular Momentum, Eigen value of J^2 and J_z, Angular Momentum matrices, Matrices for J_+, J, J_x and J_y Spin angular momentum, Spin vectors for Spin (1/2) system, Addition of Angular momenta, Clebsh- Gordan Coefficient.

Unit-3

NMR and NQR Techniques: Theory of MR - Bloch equations - Steady state solution of Bloch equations -Theory of chemical shifts - Experimental methods - Single Coil and double coil methods - Pulse Method - High resolution method - Applications of NMR to quantitative measurements. Quadruple Hamiltonian of NQR Nuclear quadruple energy levels for axial and nonaxial symmetry - Experimental techniques and applications.

Unit-4

LASER: Requisites for producing LASER light, Basic principles, Einstein coefficients and Light Amplification, The threshold condition, Line broadening mechanism: Natural broadening, Collision broadening and Doppler broadening. Laser Rate Equation, Optical Resonators: Modes of a rectangular cavity, Spherical resonators, The Quality factor, Mode selection, Dye Laser, Excimer Laser.

Reference Books

1. Principles of Quantum Mechanics, R. Shankar, Springer
2. LASERS Theory and Applications - by K. Thyagarajan and A. *K.* Ghatak (Macmillan India Ltd., 2008).
3. Lasers and Non-linear Optics-by 8. 8. Laud (New Age International (P) Ltd., India, Second edition, 1996) .
4. Atom, Laser Spectroscopy - by S. . Thakur D. K. Rai, PHI Learning Pvt. Ltd. New Delhi
5. LASER Fundamentals : Silfvast (Cambridge University , Press)
6. LASER's: Siegman (Univ.Science Books, USA)
7. Elements of Quantum Optics: Meystre and Sargent (Spriger - Verlag)
8. LASER Physics: Srgent, Scully and Lamb

9. Essentials of LASER and non - linear optics: Baruah Pragati Prakashan, Meerut)

10. Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, Spinger Verlag, New York.

11. Raymond Chang, 1980, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo

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M.Sc. Physics Syllabus

Semester-2

CORE Paper. Physics Laboratory
Course Code: PPH-2805L
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Will be able to demonstrate the Inverse square law and end point energy of beta particles GM tube.
2. CO2: Will be able to demonstrate the Ultrasonic Interferometer.
3. Will be able to demonstrate the Dipole Moment of organic molecule Acetone.
4. Will be able to demonstrate the Velocity of Liquid using Surface wave.
5. Will be able to demonstrate the Dielectric constant of a non-polar liquid
6. Will be able to demonstrate the Hall Effect.
7. Will be able to Measure the Lattice dynamics
8. Will be able to demonstrate Stefan's Constant of Radiation
9. Will understand the application of Ultrasonic Interferometer.
10. Will be ready to demonstrate application of dipole moment and dielectric constant

Course Structure

1. GM counter experiment (To verify Inverse square law and end point energy of beta particles GM tube)
2. Ultrasonic Interferometer

3. Dipole Moment of organic molecule Acetone
4. Velocity of Liquid using Surface wave
5. Dielectric constant of a non-polar liquid
6. Hall Effect
7. Measurement of Lattice dynamics
8. Stefan's Constant of Radiation

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M.Sc. Physics Syllabus

Semester-2

CORE Paper. Electronics Laboratory
Course Code: PPH-2806L
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Will be able to demonstrate the active filters using OPAMP.
2. Will be able to demonstrate the Wien Bridge Oscillator using OPAMP.
3. Will be able to demonstrate the Digital Design using Kanaugh Map.
4. Will be able to demonstrate the Digital Design using Multiplexer.
5. Will be able to demonstrate the conversion of Flip-Flop.
6. Will be able to demonstrate the decade asynchronous counter using 7490 IC.
7. Will be able to demonstrate the up-down synchronous counter using 74193 JC.
8. Will be able to demonstrate microprocessor programming.
9. Will understand the application of OPAMP and practical use.
10. Will be ready to design the circuit using OPAMP and flip-flop.

Course Structure

1. Active Filters Using OPAMP
2. Wien Bridge Oscillator Using OPAMP
3. Digital Design Using karnaugh map

4. Digital design using Multiplexer
5. Conversion of Flip-Flop
6. Decade Asynchronous Counter using 7490 TC
7. Up-Down Synchronous Counter using 74193 IC
8. Microprocessor programing