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

M.Sc. Physics Syllabus

Semester-3

CORE Paper. Electronic Communication and Microprocessor Interfacing
Course Code: PPH-3801
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Understand the importance of the modulation in the communication
2. Get information about different types of the modulation.
3. Learn theory of Amplitude modulation and different techniques through numerical, learn theory of FM wave through numericals.
4. Get idea of generation of side band and bandwidth of the FM signal.
5. Learn practical circuit used for generation of AM and FM wave.
6. Learn the principle of FM demodulation and different FM detectors used in the FM receiver.
7. Learn the pulse modulation technique including pulse amplitude, pulse width, pulse position and pulse code modulation.
8. *Also* learn the digital modulation including ASK, FSK, and PSK.
9. Study the microprocessor 8085 with its advanced instruction sets including stack, subroutines, call and return instruction
10. Study the interfacing of microprocessor kit with peripheral devices such as DAC and 8255
11. Solve numerical based on above concepts and topics.

Course Structure

Unit-1

Amplitude modulation: Elements of analog communication, Amplitude modulation technique, Time domain representation of AM wave, power relation in AM wave, current relation in AM wave, modulation by several sine wave, Double sideband suppressed technique, single sideband technique, vestigial sideband modulation technique, Generation of AM signal. Angle modulation: Frequency modulation, phase modulation, comparison of frequency and phase modulation, frequency spectrum of FM wave, comparison of FM and AM wave, Generation of FM, Direct methods Basic FM demodulators, slope detection, Balanced slope detector, phase discriminator, ratio detector

Unit-2

Pulse Modulation Technique: Pulse amplitude modulation, pulse width modulation, pulse position modulation, pulse code modulation, Delta modulation, Differential code modulation, De- modulation of pulse digital modulated signal Digital Modulation Technique: Amplitude shift keying, Frequency shift keying, Phase shift keying Satellite communication: Satellite system, fixed satellite service, satellite communication Earth station, Antenna for satellite communication, advantages of cassegrain antenna, Antenna feed, Antenna structure.

Unit-3

Principle of light transmission in a fiber - propagation with in a fiber, fiber index profiles, Modes of propagation - overview of modes, key modal concepts, Maxwell's equations, waveguide equations for cylindrical fiber, wave equations for step index fiber, modal equation, modes in step index fiber, single mode fiber. Losses in fibers - absorption losses, leaky modes, mode coupling losses, bending losses, combined fiber losses. Dispersion - effect of dispersion on pulse transmission, intermodal dispersion, material (chromatic) dispersion, total dispersion and maximum transmission rates. Light sources and detectors for fiber optics. optical receiver circuit. Connectors and splices - losses in connectors and splices, connectors, fiber splices. Fiber optic communication link.

Unit-4

A: Stack; Subroutine; Restart, Conditional Call and Return Instructions; Advanced Subroutine Concepts.
B: The 8255A Programmable Peripheral Interface, Block Diagram of the 8255A; Mode 0: Simple Input or Output Port.
C: DAC Specifications; DAC 0800; DAC interfacing

Reference Books

1. Kennedy's Electronic communication systems by Kennedy, Davis Prasanna (5th ed)
2. Electronics communication By Roddy and Coolen, 4th edition

3. Hand Book of Electronics by Kumar and Gupta
4. Electronics and Radio engineering By M L Gupta
5. Tosmasi W., Advanced Electronic Communication system, PHT.
6. Keiser G, Optical fiber communications, MGH, 2000
7. Senior J.M., Optical Fiber Communications - Principles and practice, Pearson, 2007
8. Fiber Optics and Optoelectronics, R. P. Khare
9. Microprocessor Architecture, Programming and Applications with 8085 5th edition by Ramesh Gaonkar for Units A and B:
10. 8 Bit Microprocessor-V.J. Vibhute and P.B. Borole

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

M.Sc. Physics Syllabus

Semester-3

CORE Paper: Nano Science & Photo Voltaic System
Course Code: PPH-3802
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Learn some of the physical and chemical methods for the fabrication of Nanomaterials including various vacuum and non- vacuum deposition techniques

2. Understand some of the basic and advanced characterization techniques used to study the nanomaterial's as well as thin films.

3. Understand generation and separation of electron-hole pair in a photovoltaic device.

4. As well as collection of charges, generation of photo-voltage and flow of current through photovoltaic device.

5. And study some of the solar cell characterizations, working configurations, solar cell structures and practical working problems of solar cells.
6. Understanding the solar simulator 1-V measurements and quantum efficiency (QE) measurements.
7. Study of series and parallel connections of cell and mismatch in cell module.

8. Solve numerical based on above concepts and topics.

Course Structure

Unit I: Nanoscience Nanomaterials

Importance of Nanosciences, Size effects : Structural, Mechanical, Optical, Chemical, Magnetic and Electrical properties of nanomaterials, Quantum dots, Quantum wells and Quantum wires

Carbon Nanotubes : Types of CNTs, Formation of nanotubes - Various techniques - Preparation and properties of nanotubes – Applications of nanotubes; processing for nanotube,

Applications of nanomaterials in Industry, Medicine, Textile

Unit II Synthesis of Nanomaterials :

Physical vapour deposition : Thick & Thin Films, Evaporation Theory, Physical Vapour Deposition methods, Thermal, Electron Beam, Thin film growth stages, Pulsed laser deposition, Chemical vapour deposition (CVD) techniques

Introduction, Colloids and Colloids in Solutions, Growth of nano particles, Micro emulsions, Chemical solution deposition technique, Spin coating

Unit III: Characterization Techniques

Structural characterization : X-ray diffraction (XRD), Grazing Incidence XRD, Surface characterization : Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Raman spectroscopy, Optical properties : UV.-Vis. Spectroscopy, Photoluminescence (PL) spectroscopy

Unit IV: Photo Voltaic System

P-N Junction under illumination: solar cell, Generation of photo voltage, Light generated current, 1-V equation of solar cells, solar cell characteristics. Generation of carriers: rate of generation, absorption coefficient. Recombination of carriers: carrier life time, band to band recombination, Trap assisted recombination, Auger recombination. Losses in solar cell, effect of series and shunt resistance on efficiency. Analytical techniques: solar simulator 1-Y measurement, Quantum efficiency (QE) measurement, minority carrier Life time and diffusion length measurement. Solar PY modules from solar cells: series and parallel connections of cell and mi match in cell module. Mismatch in series connection, Hot spots in the module, By pass diode, mismatching in parallel connection.

Reference Books :

Unit-I-III

1. Milton Ohring, The Materials Science of Thin Films, Academic Press

2. G. Cao, Nanostructures and Nanomaterials, Imperial College Press (2004)
3. Robert Kelsall, Ian Hamley, M. Geoghegan, Nanoscale Science & Technology John Wiley (International) Publications
4. K.K. Chattopadhyaya & A.N. Banerjee, Introduction to Nanoscience & Nanotechnology by, PHI Learning, New Delhi
5. Solar Photovoltaics [Fundamentals, Technologies and Applications] by Chetan Singh Solanki (PHT Learning Private Limited, second edition 2013)
6. Nano-science and Technology by V.S. Muralidharan and A. Subramania (Ane Book Pvt. Ltd.).
7. Introduction to nanotechnology by Charles P. Poole, and Frank J. Owens (Wiley Tndia Pvt. Ltd
8. Nanotechnology: Principles and practice: SulbhaKulkarni.Capital Publishing Company
9. Nano: The Essentials -Understanding nanoscience and nanotechnology by T. Pradeep (McGrawHill Education).
10. Semiconductor material and Devices Characterization, By Dieter K. Schroder, John Wiley and Sons, NY1990. 1 Dr. Savan Patel
11. Integrated circuits by K R. Botkar (Khanna Publishers).
12. Handbook of thin film technology by LI. Maissel and R. Giang (McGraw-Hill).
13. The Materials Science of thin films by Milton Ohring (Academic press)
14. Thin Film Phenomena by K. L. Chopra (McGraw-Hill).
15. Solar Photovoltaics [Fundamentals, Technologies and Applications] by Chetan Singh Solanki (PHT Learning Private Limited, second edition 2013)
16. Electronic Devices and Components, by J Seymore (Longmann Scientific Technical)
17. integrated Electronics, by K. R. Botkar, (Khanna Publishers.)
18. Integrated Electronics: Analogand Digital Circuits Systems, by J Millman and C. C. Halkias (Tata McGraw -Hill Publishing Company Ltd.)
19. Solid State Pulse Circuits, by David A. Bell (Prentice Hall of lndia Pvt. Ltd)
20. Energy Technology (Non-conventional, Renewable and conventional), by S. Rao and Dr. P.B. Parulkar (Khanna Publishers.)

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M.Sc. Physics Syllabus

Semester-3

CORE Paper. *Adv.* Topics in Quantum and Statistical Mechanics
Course Code: PPH-3803
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. Have a working knowledge of differentiability for complex functions and be familiar with the Cauchy-Riemann equations
2. To evaluate integrals along a path in the complex plane and understand the statement of Cauchy's Theorem, use Green functions.
3. Clarify the basic concepts of scattering and illustrate Rutherford's scattering experiment. Describe scattering amplitude and scattering crosssection and also apply partial wave analysis to find the same.
4. Establish the expansion of a plane waves in terms of infinite number of spherical waves and obtain Bauer's formula.
5. Give example of scattering by an attractive square well potential.
6. Outline the Born approximation and explain the validity of Born approximation and also develop skill to compute the phase shift for s and p wave scattering.
7. Will be able to demonstrate good understanding of fluctuations, its power spectrum and
8. will be able to apply it to study various types of noise.
9. Will be able to demonstrate good understanding of critical phenomena occurring at phase transition.
10. Have a basic understanding of the phase transitions,
11. Have a deep understanding of universality in second order phase transitions.
12. Will be familiar with order of phase transition and Clusius-Clayperon equation.
13. Understanding of Curie-Weiss theory of Magnetic transition.

14. Will be able to demonstrate Tsing Model in zeroth approximation

Course Structure

Unit-1

Green's function method of solving inhomogeneous differential equations, Boundary Conditions, Application to One-dimensional problems.
Cauchy-Riemann equations and their applications. Analytic and Harmonic Functions. Complex integrals. Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy integral formula and its corollaries, Series - Taylor and Laurent expansion, classification of singularities, branch point and branch cut, residue theorem and evaluation of some typical integrals using this theorem.

Unit-2

Scattering Cross Section, Scattering Amplitude, Partial waves, Scattering by a central potential: Partial Wave Analysis, Significant Number of Partial Waves, Scattering by an Attractive Square -well Potential, Briet Wigner Formula, Scattering Length, Expression for Phase Shifts, Integral Equation, The Born Approximation, Scattering by Screened Coulomb Potential, Validity of Born Approximation, Laboratory and Center of Mass Coordinate systems.

Unit-3

Fluctuations: Brownian motion, Langevin theory of random motion, Time dependence of fluctuations, Power spectrum of fluctuation, Persistence and correlation of fluctuation, Wiener - Khinching theorem, Johnson noise - Nyquist theorem, Shot noise, Fokker-Planck equation.

Unit-4

Critical phenomena and phase transitions: Phase transitions, Condition for phase equilibrium, First order phase transition, Clusius- Clayperonequation, Second order phase transition, The Critical exponent, Van der Walls theory of Gas - Liquid condensation, Co - operative processes, Curie - Weiss theory of Magnetic transition, Ising Model, Ising Model in zeroth approximation, Exact solution of one dimensional Ising Model, Order parameters

Reference Books

1. Mathematical Methods for Physicists by G. Arfken Weber, Academic Press, 6th Ed (2005)
2. Mathematical Physics by P. K. Chattopadhyay (Wiley Ea tern Limited, (1990)
3. Mathematical Methods for Physicists by G. Arfken Weber, Academic Press, 6th Ed (2005)
4. Modern Quantum Mechanics, J. J. Sakurai & Jim apolitano, Pearson
5. Statistical Mechanics - Theory and Applications by S.K Sinha, arosa Publishing House, New Delhi.
6. Statistical Mechanics and Properties of Matter by E.S. Raja Gopal, McMillan Company of

India Limited.

7. Statistical Mechanics - An Introduction by Evelyn Guha, Narosa Publishing House
8. Funadamentals of Statistical Mechanics by F. Reif, McGraw Hill Companies
9. Statistical Mechanics by R.K. SrivastavaJ.Ashok:mPrintice Hall of India
10. Fundamentals of Statistical Mechanics by John D. Walecka, World Scientific
11. Landau and Lifshitz, Landau theory of phase transition Statistical Physics

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M.Sc. Physics Syllabus

Semester-3

CORE Paper. Astronomy and Statistical Methods in Physics
Course Code: PPH-3804
No. of credits: 4
Learning Hours: 60

Course Objectives

At the end of the course student will be able to

1. To introduce the fundamental concepts of celestial sphere, coordinate systems, stellar properties, and methods of astronomical observations.
2. To develop an understanding of stellar spectra, spectral classification, and the physical processes governing spectral line formation.
3. To study the structure, stability, and evolution of stars from main sequence to compact stellar remnants such as white dwarfs, neutron stars, and black holes.
4. To explore the interstellar medium, galaxy classification, Hubble’s law, and phenomena such as active galactic nuclei, gamma-ray bursts, and exoplanets.
5. To provide a foundation in statistical methods relevant to physics, including descriptive statistics and probability distributions.
6. To train students in error analysis, uncertainty propagation, and regression techniques with practical implementation in Python.
7. To enable hypothesis testing, significance testing, and goodness-of-fit analyses for real experimental datasets in physics.
8. To introduce Monte Carlo methods and random number simulations for modeling physical processes and problem-solving in physics.

Course Structure

Unit – 1

Celestial Sphere; Coordinate systems; Time; Observable quantities; Continuum radiation from Stars; Terminology - Brightness, Luminosity, Magnitude scale, colour; Size and Distance; Stellar spectra and spectral classification of stars. Formation of spectral lines - line broadening - curve of growth; Local Thermodynamic Equilibrium - Saha's equation; HR diagram; Binary stars and determination of stellar parameters

Unit – 2

Main sequence phase of stars - Energy sources; Equations for Stellar interiors - stability; Atmospheres of stars; Post-main sequence evolution of stars; Fate of stars at the late stages of evolution - Mass loss - Planetary nebulae - supernovae; Chandrasekhar limit - Degenerate core remnants - White Dwarfs - Neutron stars - Black Holes; Interstellar medium and Star formation; Galaxies and their classification; Hubble's law; Introduction to Active Galactic Nuclei and Gamma Ray Bursts; Extra-solar planets.

1. Fundamental Astronomy, Hannu Karttunen, Springer

Unit – 3

Importance of statistics in physics; Descriptive statistics: Mean, median, mode, variance, standard deviation; Probability distributions: Binomial, Poisson, Gaussian; Python implementation using numpyand scipy.stats

Lab/Exercise:

a. Generating and visualizing distributions using matplotliband seaborn

***Referenced Reading*:**

R.J. Barlow – *Statistics*, Chapters 1, 2, 3

Allen B. Downey – *Think Stats*, Chapters 1, 2, 5

Measurement errors: Systematic vs. random errors; Uncertainty propagation formulas; Least squares fitting and regression; Python implementation using curve_fitfrom scipy.optimize

Lab/Exercise:

b. Simulating measurement errors and error propagation
c. Fitting experimental data using Python

***Referenced Reading*:**

- Bevington & Robinson – *Data Reduction and Error Analysis*, Chapters 1 (1.1–1.8), 2 (2.1–2.5), 6
- R.J. Barlow – *Statistics*, Chapter 6

Unit – 4

Confidence intervals and significance testing; Chi-square test and goodness-of-fit; t-test and p-values; Python implementation using scipy.stats

Lab/Exercise:

d. Testing hypotheses with real physics datasets
e. Chi-square analysis for experimental data

***Referenced Reading*:**

- Glen Cowan – *Statistical Data Analysis*, Sections 3.1–3.5, 5.1–5.4
- Downey – *Think Stats*, Chapters 7–
- Sivia & Skilling – *Data Analysis: A Bayesian Tutorial*, Chapters 1–2 (optional)

Random number generation and its importance in physics; Simulating simple physical systems (e.g., radioactive decay, coin toss experiments); Basic Monte Carlo methods; Python implementation using numpy.random

Lab/Exercise:

f. Monte Carlo estimation of π
g. Simulating a simple physical process (e.g., radioactive decay or random walks)

***Referenced Reading*:**

- Allen B. Downey – *Think Stats*, Chapter 4, Chapter 10
- Bevington & Robinson – *Data Reduction and Error Analysis*, Chapter 11

Reference Books:

h. Glen Cowan – *Statistical Data Analysis*
i. ***Sivia & Skilling – Data Analysis: A Bayesian Tutorial***

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M.Sc. Physics Syllabus

Semester-3

CORE Paper. Physics Laboratory
Course Code: PPH-3805L
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 Frank - Hertz Experiment.
2. Will be able to do the Fourier Analysis.
3. Will be able to Study the Dielectrics.
4. Will be able to learn the properties and application of Lasers.
5. Will be able to demonstrate the Young's Modulus using Flexural Vibrations.
6. Will be able to demonstrate the Faraday Effect.
7. Will be able to Measure the low Resistance using Lock-in Amplifier.
8. Will be able to Measure the Permeability of Air.
9. Will understand the application of Fourier Analysis.
10. Will be ready to demonstrate application of dielectric constant and laser experiment.

Course Structure

1. Frank - Hertz Experiment
2. Fourier Analysis
3. Study of Dielectric Constant
4. Laser Experiment-II
5. Young's Modulus using Flexural Vibrations
6. Faraday Effect
7. Measurement of low Resistance using Lock-in Amplifier
8. Measurement of Permeability of Air

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

M.Sc. Physics

Syllabus

Semester-3

CORE Paper. Electronics Laboratory
Course Code: PPH-3806L
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 DC Characteristic of SCR.
2. Will be able to demonstrate the SCR as Half Wave Rectifier.
3. Will be able to demonstrate the Astable Multivibrator using IC 555.
4. Will be able to demonstrate the Monostable Multivibrator using IC 555.
5. Will be able to demonstrate the UJT as Relaxation Oscillator.
6. Will be able to demonstrate the RC Phase Shift Oscillator.
7. Will be able to demonstrate the D/A Converter.
8. Will be able to demonstrate Microprocessor Interfacing with PPI 8255
9. Will understand the application of SCR and practical use.
10. Will be ready to design the circuit using SCR and Multivibrator.

Course Structure

1. DC Characteristic of SCR
2. SCR as Half Wave Rectifier
3. Astable Multivibrator using IC 555
4. Monostable Multivibrator using IC 555
5. UJT as Relaxation Oscillator
6. RC Phase Shift Oscillator
7. ***D/ A*** Converter
8. Microprocessor Interfacing with PPI 8255