

Course Outcomes:

CO1: The students are expected to become skilled, both theoretically and practically, in computer programming and are expected to be able to solve numerical problems that are frequently used in physics using computer programs.

Course Content:

Numerical Analysis: Solution of non-linear equations - Newton's method, method of false position (regular falsi), solution of a system of linear equations - Gaussian elimination, iterative methods (Jacobi and GaussSeidel methods), Interpolation - Newton's interpolation formula, numerical differentiation and integration Simpson's rule, trapezoidal rule, quadrature formula, numerical solution of ordinary differential equations Euler's method, Runge-Kutta method, fitting of curves - principle of least squares.

Simulation: A system and its model, the basic nature of simulation, the simulation of continuous and discrete systems - suitable examples, stochastic simulation - generation of random numbers with different probability distributions, examples of simulation in physics.

Text Books:

1. Mathews, J. H., *Numerical Methods for Mathematics, Science and Engineering*, (Prentice Hall, 1997).
2. Narsingh Deo, *System Simulation with Digital Computers*, (Prentice Hall, 1979).

Suggested Readings :

1. Yashwant Kanetkar, *Let us C*, (BPB Publications, 2012).
 2. Gottfried, B .S., *Schaum's outline of theory and problems of programming with C*, (McGraw Hill Professional, 1996).
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Course Outcomes:

CO1: Students should be able to connect characteristics properties of the theoretical models.

CO2: Students are expected to familiarize with various experimental tools and characterization techniques of different experiments in physics.

Course Content:

1. To design and fabricate a phase shift oscillator for the given frequency and to study the output using OpAmp. 741/ 324 / 325.
2. Determination of thermal conductivity of a substance by Lee's method.
3. Scintillation counter:
 - a. Find out the resolution and the FWHM of the given Scintillation counter.
 - b. Find out the gamma ray energy of the given radioactive sources.
4. Determination of the Young's modulus of a beam by four-point bending.
5. To determine the velocity of sound in (a) dry air, and (b) rods by Kundt's tube method.
6. Calculate the difference in wavelength between atomic transition lines and Zeeman lines using Zeeman effect set-up. (SES instruments Pvt. Ltd).
7. To study Talbot imaging and to obtain Talbot distances with moiré interferometry and to measure the focal length of a lens.
8. Determination of the boiling point of a liquid by platinum resistance thermometer and metre bridge.
9. To measure the diameter of a thin wire using (a) interference, and (b) diffraction and compare the results.
10. To measure the dielectric constant and loss using microwave bench.

Course Outcomes:

CO1: The Students should have acquired the knowledge with adequate facts and illustrations and thereby gathered the expertise in designing relevant application oriented schemes.

Course Content:

Op Amp non-linear applications: Voltage limiters, comparators, zero detector, Schmitt trigger, voltage to frequency and frequency to voltage converter, small-signal diodes, sample-and-hold circuits and signal generators: oscillators-square-wave, Wien bridge, phase shift.

Frequency response of an op-amp and active filter: Gain and phase shift vs. frequency, Bode plots, compensated frequency response, slew rate, active filter, first and second order low pass and high pass, Butterworth filter, band reject filter. 555 timer: monostable, astable.

Digital Electronics: Review of Boolean algebra, gates, transistor switching times, INHIBIT (ENABLE) operation, De Morgan's laws, gate assemblies, binary adders.

Combinatorial digital systems: arithmetic functions, decoder/demultiplexer, data selector/multiplexer, encoder, ROM and applications.

Sequential digital systems: flip-flops, shift registers and counters, random access memory (RAM), dynamic MOS circuits, MOS shift registers, MOS Read Only Memory, D/A and A/D systems, digital-to-analog converters, analog-to-digital converters, character generators.

Microprocessor: Architecture and Laboratory.

Text Books:

1. Kumar, A., *Fundamentals of Digital Electronics* (PHI Learning Pvt. Ltd., 2003).
2. Gayakward, R.A., *Op-Amps and Linear Integrated Circuits*, 3rd Edition, (PHI, 2001).

Suggested Readings :

1. Malvino A.P. and Leach D.J., *Digital Principles and Applications*, (Tata McGraw Hill 1994).
2. Gaonkar R.S., *Microprocessor Architecture, Programming, and Applications with the 8085*, 5th Edition, (Prentice Hall, 2002).
3. Milliman, J. & Halkias, C.C., *Integrated Electronics*, (Tata McGraw Hill, 2003).
4. Tocci R.J., *Digital Systems*, (Pearson/Prentice Hall, 2004).
5. Bartee T.C., *Digital Computer Fundamentals*, (Tata McGraw Hill Publishing Company, 1985).

PH 455: Seminar
CR1)

(LO-T0-P1-CH2-

Course Outcomes:

CO1: The students will be able to prepare and present a scientific work.

Course Content: In this course, each students will give a seminar of about 20 minutes of duration on any topical subject of physics. The students will consult any faculty for the specific topic and the finalized topic should be endorsed by the faculty. The students will go thorough the details of the topic and will learn to do a thorough literature survey which will include exploring the current reasearch articles. Finally the student will prepare a presentation and give a seminar talk.

Course Outcomes:

CO1: The students should be able to connect characteristics properties of the theoretical models.

CO2: The students are expected to familiarize with various experimental tools and characterization techniques of different experiments in physics.

Course Content:

1. Electron spin resonance spectrometer:
 - a. To find out the Lande' g – factor of 2,2-Diphenyl-1-picrylhydrazyl sample using ESR spectrometer.
 - b. To observe the E.S.R. signal of given sample (DPPH) and to measure its full width at half maximum (FWHM).
2. GM counter:
 - a. Determine the resolving time of the GM counting system.
 - b. Study and determine the statistical distribution law that governs nuclear decay.
 - c. Determine the characteristics of a GM tube to study the variations of count rate with applied voltage and thereby determine the plateau, the operating voltage and the slope of the plateau.
 - d. Determine the dead time of the GM tube using a single source.
3. To determine the coercivity, saturation magnetization and retentivity of different given samples using hysteresis loop tracer set-up.
4. To measure the impedance of a coaxial cable and a rectangular waveguide using microwave bench.
5. Determine the dielectric constant of the ferroelectric ceramic sample using the given experimental set-up.
6. Determine the electrical charge of an electron by Millikan oil drop experiment and determine the value of e/m .
7. To study response of a non-linear crystal as a function of intensity of Nd:YAG laser (532nm)
8. a. To plot intensity of Luminescence vs. Temperature glow curve using thermo-luminescence set-up.
b. To draw the glow curve and find out the activation energy (E) of different Alkali Halide Crystals using thermo-luminescence set-up (Demonstration only)
9. To study, take a measurement and prepare a report on
 - a. PL/UV-VIS Spectrophotometer
 - b. Scanning Electron Microscope (SEM).
X-Ray Diffractometer (XRD).

Course Outcomes:

CO1: The students will be able to develop analytical and problem solving skill through project activities.

CO2: The students will also be able to apply basic theoretical understanding to physics experiments and learn the use of numerical methods and simulations

CO3: The students will get familiar with contemporary research within various fields of physics and have the background and experience required to model, analyze and solve advanced problems in physics.

Course Content : The student will work on a contemporary research topic under the supervision of a guide assigned, based on their choice of specialization and availability. The student will prepare a detailed project report in the given format and will also present and defend the work in a presentation-cum-viva voce

Course Outcomes:

CO1: The students will be able to calculate energy levels, frequencies of spectral lines of alkali and alkaline earth spectra and learn to apply quantum mechanical processes in the field of spectroscopy.

CO2: The students will be able to apply the knowledge of molecular spectroscopy as a tool in understanding the material properties and for analysing the data received from astrophysical objects.

Course Content:

Atomic emission and absorption spectra (AES and ASS), series spectra in alkali and alkaline earths, LS and jj coupling in central field approximation.

Spectra of diatomic molecules, pure rotation, pure vibration; vibration-rotation and electronic spectra, BornOppenheimer approximation and its application to molecular spectroscopy, formation of bands, structure of bands, dissociation and pre-dissociation, valence-bond theory, molecular orbital theory, bonding and antibonding of electrons for equal nuclear charges, energy level of symmetric top molecules, potential energy function. Morse potential function, Raman spectroscopy, electron spin resonance (ESR) spectroscopy, nuclear magnetic resonance (NMR) spectroscopy, Mossbauer spectroscopy.

Text Books:

1. White, H. E., *Introduction to Atomic Spectra*, (McGraw-Hill, New York, 1934).
2. Banwell, C. N. and McCash E. M., *Fundamentals of Molecular Spectroscopy*, (McGraw-Hill, 1994).

Suggested Readings :

1. Kuhn, H. G., *Atomic Spectra*, (Longmans, 1969).
2. Ruark, A. E., and Urey, H. C., *Atoms, Molecules and Quanta*, (McGraw-Hill, 1930).
3. Siegman A. E., *Lasers*, (University Science Books, 1986).
4. Herzberg, G., *Atomic Spectra and Atomic Structure*, 2nd edition, (Dover Publications, 2010).

Course Outcomes:

CO1: The students will develop analytical and problem solving skill and apply knowledge earned through project activities to solve problems.

CO2: The students will also be able to apply basic theoretical understanding to physics experiments and learn the use of numerical methods and simulations.

CO3: The students will be familiar with contemporary research within various fields of physics and have the background and experience required to model, analyze and solve advanced problems in physics.

Course Content: The student will work on a contemporary research topic under the supervision of a guide assigned, based on their choice of specialization and availability. The project can be either a new one or a continuation of the work started in the 3rd semester. The student will prepare a detailed project report in the given format and will also present and defend the work in a presentation-cum-viva voce

Course Outcomes:

CO1: The students will know concept of digital signal processing and some typical applications along with its implementation with MATLAB. **Course Content:**

Introduction: digital signal processor, signals and systems, sampling and quantization, Specialized transforms: z-transform, discrete cosine transform, Hilbert transform, Fourier transform, DFT, FFTs, convolution.

Digital filters:

FIR filters-Linear phase filter, windowing method, standard and multi band, constrained least square filtering, arbitrary response filter design IIR filter- design, Butterworth, Chebyshev type I and type II, elliptical, Bessel.

Spectral analysis: Welch's method, multilayer method, Yule-Walker method, covariance methods, MUSIC and eigenvector analysis method.

Applications in real time problems like extraction of voice from noisy environment, filtering the signal using digital filters etc.

Text Books:

1. Proakis, J. G. and Manolakis, D. G., *Digital Signal Processing: Principles, Algorithms, and Applications*, 3rd edition, (Prentice Hall, 1996).
2. Mitra, S. K., *Digital Signal Processing: A Computer Based Approach*, (McGraw-Hill, 2001).

Suggested Readings :

1. Hayes, M. H., *Digital Signal Processing*, Schaum's Outline Series, (McGraw-Hill, 1999).
2. Oppenheim, A. V. and Schaffer, R. W., *Digital Signal Processing*, (Macmillan Publishing Company, New York, 1993).
3. Porat, B., *A course in Digital Signal Processing*, (John Wiley & Sons, 1996).
4. Soliman, S. S. and Srinath, M. D., *Continuous and Discrete Signals and Systems*, (Prentice Hall, 1998).
5. Sharma, S., *Signals and Systems*, (Katson Books, 2010).
6. Lyons, R. G., *Understanding DSP*, 3rd edition, (Pearson Education, International, 2010).

PH 525: Microprocessor and Digital Signal Processing Based Systems (L1-T0-P2-CH5-CR3)

Course Outcomes:

CO1: The students will know how to interface hardware, acquire and process data.

Course Content:

Introduction to microprocessors programming and interfacing, Transducers and sensors: Load cells, strain gauges, weighing transducers, temperature sensors (e.g. RTDs, thermocouples, semiconductor sensors, etc.), displacement sensors (e.g. LVDTs, RVDTs, encoders, linear scale etc.), proximity sensors, magnetic sensors, opto-electronic sensors, fiber optic sensors, motion transducers (velocity, vibration and acceleration), fluid transducers, pressure transducers, level transducers, etc.

The signal conditioning circuits like current booster, current to voltage converter, instrumentation amplifier, level shifter, 4-20mA current loop, etc. with their design.

The open loop, feedback loop and feed forward loop and servo controllers with details of PI, PD, PID controllers, tuning methods of the same and also auto tuning methods.

Interfacing of sensors, stepper motor designing of the signal conditioning circuits along with microcontrollers.

Text Book:

1. Hall, D., *Microprocessors and Interfacing*, 2nd edition, (Tata McGraw-Hill, 1999).

Reference Book:

1. Gaonkar R. S., *Microprocessor Architecture, Programming, and Applications with the 8085*, 5th edition, (Prentice Hall, 2002).

Course Outcomes:

CO1: The students will be able to understand and design the macroscopic properties of nano dimensional devices in terms of microscopic scale phenomena.

Course Contents:*Unit I*

Ballistic transport; Phase coherence, Aharonov – Bohm effect; quantized conductance, Landauer formula, conductance behavior of quantum point contact; Landauer – Buttiker formula for multileads, edge states – explanation of quantum hall effect; Single electron transport – Coulomb blockade, single electron transistor (SET), molecular electronics; Kondo effect in Nanostructures. [6 Lecture hours] **Unit II**

Magnons, Exchange Interactions. Magnetic Anisotropy, Order and Broken symmetry, Consequences of Broken Symmetry, Heisenberg and Ising Model, Equation of motion for Domain walls, Superparamagnetism, Stoner-Wohlfarth model, Nuclear magnetic resonance, Magnetic Resonance Imaging. [8 Lecture hours]

Unit III

Ordinary and anisotropic magneto-resistance, mechanism; Giant Magneto-resistance (GMR): basic properties, mechanism, application – spin valves and spin switches; Colossal magnetoresistance (CMR): basic properties and phase diagram, comparison with GMR; structure tolerance factor, effect of doping, charge ordering; Theoretical understanding – Double exchange mechanism, crystal field splitting and JahnTeller distortion, electron-phonon coupling, Application-Magneto-resistive devices, Applications of superconductors in quantum computation. [9 Lecture hours]

Unit IV

Family tree of FET: General characteristics – field dependent mobility, two region model and saturated velocity model, related field effect devices, Surface charge in MOS-capacitors; Capacitance voltage characteristics of MIS structure.

Types of MOSFET, Basic devices characteristics, Non-equilibrium conditions, linear and saturation regions, subthreshold region, mobility behaviour, temperature dependence, threshold shift, short channel effects, subthreshold current, FAMOS, VMOS; Charge coupled devices (CCD); interface trapped charge, charge storage, basic CCD structure, Charge storage and frequency response, buried channel CCD. [10 Lecture hours] **Unit V**

Applications of heterojunctions, white light LED, OLED, Quantum well, quantum dot and quantum cascade lasers, photodetectors and photovoltaics. Space charge limited current, Fowler Nordheim equations, field emission devices.

Magnetic Memory, Shape memory, resistive switching, DRAM and FRAM, piezoelectric transducers and actuators, spin injection, transport and spin valve devices. [6 Lecture hours]

Text Books:

1. N. W. Ashcroft, N. D. Mermin, *Solid State Physics*, (Cengage Learning Asia Pvt Ltd, Singapore, 2016).
2. M. P. Marder, *Condensed Matter Physics* (John Wiley & Sons, 2010).

Suggested Readings :

1. Philip Phylips, *Advanced Solid State Physics* (Cambridge University Press, 2012).
2. W. Jones, and N. H. March, *Theoretical Solid State Physics* (Courier Corporation, 1985).
3. G. Giuliani and G. Vignale, *Quantum Theory of the Electron Liquid* (Cambridge Uni. Press, 2005).
4. P. Fazekas, *Lecture Notes on Electron Correlation and Magnetism*. (World Scientific, 1999).
5. J. Solyom, *Fundamentals of the Physics of Solids, Volumes 1, 2, and 3*. (springer, 2007).
6. H. Ibach and H. Luth, *Solid State Physics* (Springer, 2009).
7. 4. D. A. Neamen, *Semiconductor Physics and Devices*, 3 rd edition, (Tata McGraw-Hill, 2002).
8. 5. B. G. Streetmann, *Semiconductor Devices*, (PHI, 2006).
9. 6. M. Shur, *Physics of Semiconductor Devices*, (PHI, 1995).
10. 7. J. Davis, *The Physics of Low-dimensional Semiconductors: An Introduction*, (Cambridge University Press, 1998).
11. University Press, 1998).
12. 8. J. P. Colinge, and C. A. Colinge, *Physics of Semiconductor Devices*, (Springer, 2007).