List of Laboratories for Postgraduate Students

Electrical Engineering Lab	
Title	Digital Circuit Design Lab
	1. Functional and design parameter analysis of basic digital circuits. 2. Design and analysis of standard cells for combinational and sequential circuits (the purpose of the above two experiments is to introduce the design and analysis approach for circuit performance parameters at lower and advanced technology nodes using schematic and layout). 3. Design the digital blocks using HDL (Verilog/VHDL) to generate its GDSII (the purpose of this experiment is to design digital circuits using Verilog/VHDL followed by its synthesis and verification to perform automated placement and routing optimization using physical designing tools to give GDSII format. 4. (a) Design various architecture of SRAM (b) Design various architecture of DRAM (the purpose of this experiment is to get acquainted with common memory architectures and analyze the performance using EDA tools).
Title	System on Programable Chip Design-Lab
	1. Building a Zynq-700 processor design in the Vivado IDE 2. Design a Microblaze processor using Xilinx Vivado. 3. Interfacing of designed Microblaze with available peripherals. 4. Design of custom peripherals using HDL. 5. Design an enhanced instruction set with custom instructions.
Title	Discrete Device Fabrication and Characterization Lab
	1. Learning and hands-on training of various vacuum technologies and thin film deposition. 2. Thin film processing of metals/ semicondutors/ insulating materials.

	3. Design and fabrication of memory devices. 4. Electrical characterization of nanoscale devices. 5. Growth of semiconductor nanostructures. 6. Fabrication and characterization of Schottky diodes and photodiodes. 7. Solution processed techniques for thin film fabrication. 8. Frequency response of a dielectric. 9. Absorption and emission spectra of semiconducting materials
Title	System on Programable Chip Design-Lab
	1. Building a Zynq-700 processor design in the Vivado IDE 2. Design a Microblaze processor using Xilinx Vivado. 3. Interfacing of designed Microblaze with available peripherals. 4. Design of custom peripherals using HDL. 5. Design an enhanced instruction set with custom instructions.
Mechanical Engineering Lab	
Title	Dynamics and Control Systems Lab
	Dynamic model development and simulation of simple mechanical systems using Matlab and Mathematica. Numerical simulation of simple mechanical systems. Stability analysis of simple mechanical systems using linear system theory namely root locus and Bode plot. Linear controller (P,PI,PD and PID) design for simple position control of mechanical systems. State space model development and dynamic simulation using Simulink. Full state feedback controller and Pole placement technique. Design of full state feedback controller. State observer and design of state observer with controller.
Title	Vibrations and Noise Control Lab
	1. Measurement of natural frequency of various systems 2. Measurement of Sound pressure level of various machines.

	3. Noise source identification using sound intensity measurement. 4. Measurement of sound transmission loss. 5. Measurement of reflection and absorption coefficients 6. Fault detection of mechanical systems such as bearings, gears, fans, blowers, pumps etc. using vibration analysis.
Chemistry Lab	
Title	Advanced Chemistry Lab
	Inorganic Chemistry: 1. Synthesis and characterization of metal complexes 2. Separation of metal ions using column chromatography 3. Electrochemical Investigation of potassium ferricyanide [K3 Fe(CN) 6] **Organic Chemistry:** **A. Techniques:** 1. Crystallization 2. Distillation 3. Steam Distillation 4. Vacuum Distillation 5. Extraction 6. Thin Layer Chromatography 7. Column Chromatography 8. Checking MP **B. Synthesis and characterization of important organic molecules.** Usual Spectroscopic Characterization (UV, IR, NMR, M.S. etc.) **Physical Chemistry:** Exp. 1: Colorimetric estimation of urease activity using UV-Vis spectroscopy. Exp. 2: Solavtochromic shift of dye molecules using absorption and fluorescence spectroscopy. Exp. 3: Preparation and characterization of silica particles under mild condition. Exp. 4: Synthesis and characterization of liquid crystal Exp. 5: Using Gaussian program predicting the transition state of organic reactions.

Physics Lab	
Title	Physics Laboratory-I
	1. Thermal diffusivity : teaches student how to do Fourier analysis of a periodic function of time. Theory involves the diffusion equation which gives thermal waves decaying in amplitude and changing in phase as they propagate. 2. Dielectric constant of benzene and dipole moment of acetone: explains the difference between polar and non- polar molecules, the concept of the local electric field different from the applied field, and the application of the ClausiusMosotti relation. 3. Verification of Curie-Weiss law for a ferroelectric using a ceramic capacitor: The ceramic capacitor contains a ferroelectric material as a dielectric with a Curie temperature around 20 oC. This provides a cheap and convenient method of verifying Curie-Weiss law. 4. Thermal relaxation of a serial light bulb: This experiment verifies the Debye's relaxation formula which is of importance in many areas. 5. B-H curve using an integrator: Uses a hard material so that measurement of the remanent induction, coercive field and energy loss in a cycle is easy. It also uses an integrator and indicates how by integrating Farady's law one may get the flux change. 6. Calibration of a Lock in Amplifier and measurement of mutual inductance of a coil and low resistance (below 1 Ohm): The Lock in amplifier illustrates phase sensitive detection. One can verify all laws of mutual inductance and measure MI of about 100 μhenry to an accuracy of 2 to 3% using a current less than 1 milliampere. 7. Geiger-Muller Counter: i) Statistical nuclear counting ii) Verification of Gaussian and Poissionian Distribution. 8. Feigenbaum and Chua circuits for non-linear dynamics: This indicates how one goes from order to chaos in a deterministic non-linear system through a process of bifurcations. The Chua circuit illustrates how a non-linear negative resistive device can be built using op-amps and illustrates bifurcation in frequencies and shows different types of attractors. 9. Tracing FM to PM transition in Ni and crystal structure transition in Shape memory alloy through resistivity measurement: The experiments on phase transitions illustrate how resistivity can be used to trace phase transitions.

	10. Percolation: To measure the percolation threshold for conductivity and show how conductivity varies near the threshold. 11. Michelson's interferometry: Laser diffraction (single, double and multiple slits, diffraction grating) 12. Fiber optics experiment: numerical aperture of optical fiber, study of single and multi mode optical fibers. Calibration of an unknown source using Gamaray spectrometer.
Title	Physics Laboratory-II
	1. Study of half-wave and full wave rectifiers. 2. Designing regulated power supply (Zener diodes, regulators) 3. Study of transistor characteristics, Using transistor as an amplifier. 4. Designing a coupled amplifier. 5. Study of various oscillators. 6. Operational Amplifiers (Adder, subtractor, Integrator and Differentiator circuits) 7. 555 Timer circuits. 8. Logic gates (AND, OR, NOT, NAND, NOR) using ICs 9. Seven segment Decoder. 10. Flip Flops 11. Measurement of cosmic muon lifetime 12. Thin Films: Deposition, resistivity, reflectivity and thickness measurement 13. Powder XRD
Biosciences and Biomedical Engineering Lab	
Title	Biochemistry Lab
	1. To prepare an Acetic-NaAcetate buffer system and validate the Henderson-Hasselbach equation.

	2. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Vis Spectrophotometer and validating the BeerLambert's Law. 3. Titration of Amino Acids and separation of aliphatic, aromatic, and polar AA by TLC. 4. An enzyme purification theme (such as E. Coli alkaline phosphatase): (a) Preparation of cell-free lysates, (b) ammonium sulfate precipitation, (c) Ion-exchange chromatography, (d) Gel filtration, (e) Affinity chromatography, (f) Generating a purification table, (g) Assessing purity by SDS0PAGE gel electrophoresis, (h) Assessing purity by 2D-gel electrophoresis, and (i) Enzyme kinetic parameters: Km, Vmax, and Kcat
Title	Genetic Engineering Lab
	1. Isolate genomic DNA from Bacillus subtilis (or equivalent organism) genome 2. PCR amplification of flgM gene and analysis by agarose gel electrophoresis 3. Preparation of plasmid pET-28a from E. coli DH5a and gel analysis 4. Restriction digestion of vector (gel analysis) and insert with NcoI and XhoI 5. Vector and insert ligation, b. Transformation in E. coli DH5a. 6. Plasmid isolation and confirming recombinant by PCR and RE digestion. 7. Transformation of recombinant plasmid in BL21(DE3). 8. Induction of FlgM protein with IPTG and analysis on SDS-PAGE. 9. Purification of protein on Ni-NTA column and analysis of purification by SDS-PAGE. 10. Random primer labeling of flgM with Dig-11-dUTP 11. Southern hybridization of B. subtilis genome with probe and nonradioactive detection
Title	Microbiology Lab

	1. Introduction to Light Microscopy, Laboratory Procedure for Microscopic Examination 2. Introduction to laboratory sterilization technique, Media Preparation; Bacterial Culture Media preparation and sterilization 3. Bacterial Isolation, Culturing Techniques and Microscopic Examination of Bacterial Morphology, Structures, Motility. 4. Antigen-Antibody Reactions; Agglutination and Precipitation Techniques 5. Introduction to virological methods and techniques. Animal cell culture techniques, cell propagation, cell counting, maintenance 6. Quantification of virus by plaque assay. Reverse transcription PCR techniques 7. Enzyme-Linked Immunosorbent Assay (ELISA) assay for viral antigen detection, Western Blot 8. Cell staining and immunoflurescence techniques, Image acquisition through epiflurescence techniques.
Astronomy, Astrophysics and Space Engineering Lab	
Title	Astronomy Laboratory I
	Introduction to Practical Scientific Computing Python programming with the use of numerical and scientific libraries (numpy, scipy, matplotlib). **X-ray Data Analysis** CIAO software platform, Chandra X-ray Observatory Data Analysis, CCD device study **Use of Archival data for application to Astronomical systems** Introduction to tools for data retrieval & analysis from the Virtual Observatory, Stellar Type & Spectra – constructing the HR Diagram, Age and characteristics of Open Clusters (Pleiades Cluster), Shape and thickness of the disk of the Milky Way galaxy, Estimating the mass of Jupiter using the orbits of its moons, Distance to the Crab Nebula, Proper motion of Barnard's Star, Measuring the Cosmological Parameters from supernovae type I as standard candles or the period-luminosity relation of Cepheids. **Radio Astronomy Experiments** Any three (3) out of the following experiments: Faraday Rotation, Measuring the Beam Pattern of an antenna – using a signal

	generator, and then a natural source (the sun), detection of HI line in the galaxy, Superheterodyne receiver characterization
Title	Astronomy Laboratory II
	Radio Astronomy Data Analysis Visibilities, van-Cittert Zernicke theorem, the concept of a Dirty Map, Deconvolution Calibration: Band pass, Phase and Amplitude Self-calibration: Amplitude, Phase and Amplitude + Phase High Dynamic Range Imaging **Optical Observations** Four (4) experiments out of the following: 1. Measuring distance to Moon by parallax method. 2. Measuring limb-darkening of Sun. 3. Measuring relative sensitivity of B, V, and R bands of a photometer with Sun 4. Measuring extinction of the atmosphere in B, V, and R bands. 5. Characterising a CCD camera for gain, read-noise, linearity, and flat-field. 6. Estimating atmospheric seeing by measuring differential motion. **Advanced Data Analysis Techniques in Astronomy** Bayesian Statistical Inference, Regression and Model Fitting, Classification, Time Series Analysis