M.Sc.(Physics) IV-Semester Syllabus under CBCS pattern
(Academic year 2022-2023 onwards)

IV-Semester (w.e.f. 2022-2023 academic year)

Paper code	Comp. code	Title of the paper	Internal Exam Marks	End Exam		Total Max. Marks	Total Min. Marks	No. of credits
				Max. Marks	Min. Marks			
		Theory						
4.1	401	Electromagnetic Theory and Optics	20	80	32	100	40	04
4.2	402	Molecular and Resonance Spectroscopy	20	80	32	100	40	04
4.3A	403A	Solid State Physics: (Special – III) **(OR)**						
4.3B	403B	Electronics: (Special -III) Microcontrollers **(OR)**	20	80	32	100	40	04
4.3C	403C	Nanoscience SPL (Materials Science – II)						
4.4A	404A	Solid State Physics: (Special –IV) **(OR)**						
4.4B	404B	Electronics:(Special -IV) Satellite and Mobile Communication **(OR)**	20	80	32	100	40	04
4.4C	404C	Nanoscience -SPL -II						
		Practical						
4.6	406	General Physics – II	--	100	40	100	40	04
4.7A	407A	Solid State Physics (Special-I) **(OR)**						
4.7B	407B	Electronics (Special-I) **(OR)**	--	100	40	100	40	04
4.7C	407C	Nanoscience -II Practicals						
Seminar			--	25	10	25	10	01
Total						**625**		**25**

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4.1. ELECTROMAGNETIC THEORY AND OPTICS

Unit-I : **14Hrs**

Electromagnetic Potentials: Introduction to electrostatics and magnetostatics – Electrodyanamics: emf – electromagnetic induction – Maxwell's equations in differential and integral forms - Retarded potentials – Radiation from moving point charge and oscillating dipoles – Linear antenna – Radiation resistance – electric quadrupole radiation - Lienard – Wiechert potentials. General wave equation – Propagation of light in isotropic dielectric medium – Dispersion – Propagation of light in conducting medium - skin depth – Reflection and refraction at the boundary of a dielectric interface – Fresnel's equations – Propagation of light in crystals - Double refraction.

Unit-II : **10Hrs**

Waveguides: - Introduction, rectangular wave guide, transverse magnetic (TM) modes, transverse electric (TE) modes, wave propagation in the guide, power transmission and attenuation in wave guide resonators, Transverse magnetic (TM) and Transverse electric (TE) waves in circular guides.

Unit-II: **14Hrs**

Electromagnetic waves and Fibre Optics: Monochromatic plane waves in vacuum and non-conducting media,energy and momentum of electromagnetic waves,propagation through linear media,reflection and transmission at normal incidence, oblique incidence, the modified wave equation, monochromatic plane waves in conducting media, reflection and transmission at a conducting surface.

Fiber Optics: Fiber Optics Total internal reflection - Optical fiber modes and configuration – Single mode fibers – Graded index fiber structure – Fiber materials and fabrication – Mechanical properties of fibers – Fiber optic cables – Attenuation – Signal distortion on optical wave guides - Erbium doped fiber amplifiers – Solitons in optical fibers - Block diagram of fiber optic communication system - Applications of optical fibers in communication and medicine.

Unit- IV: **10Hrs**

Non-Linear Optics: Basic Principles – Origin of optical nonlinearity - Harmonic generation – Second harmonic generation – Phase matching condition – Third harmonic generation – Optical mixing – Parametric generation of light – Parametric light oscillator – Frequency up conversion

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– Self focusing of light - Guided wave optics - Pulse compression - Optical solutions.

Recommended Books:

1. Introduction to Electrodynamics **– *D.J.Griffiths***, PHI.
2. Electrodynamics **– *B.B.Laud***, New Age International**..**
3. Lasers and Non linear optics **– *B.B.Laud***, New Age International**.**
4. Optical Electronics **– *Ajay Ghatak and Tyagarajan,*** Cambridge**.**
5. Electrodynamics **– *Jordan,*** PHI**.**
6. Electrodynamics **– *Jackson,*** TMH**.**
7. Introduction to Modern Optics, ***G. R. Fowels***, 2012
8. Lasers and their Applications, ***M.J. Beesly, Taylor and Francis,*** 1976
9. Optics, E. Hecht, ***Addison Wiley***, 1974
10. Optical Fiber Communications, ***G. Keiser,*** McGraw Hill Book, 2000

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4.2. MOLECULAR AND RESONANCE SPECTROSCOPY

Unit-I: **14Hrs**

Molecular symmetry: Symmetry operations, Molecular point groups, Matrix representations of symmetry operations of a point group, Reducible and irreducible representations, Character tables for C_{2v} and C_{3v} point groups. Symmetry species of point groups, Normal modes of vibration and their distribution into symmetry species of a molecule, Infrared and Raman selection rules.

Microwave and Infrared spectroscopy: Rotation of molecules, Rotational spectra of polyatomic molecules- Linear, symmetric top and asymmetric top molecules, Diatomic vibrating-rotator, Breakdown of the Born-Openheimer approximation, Vibrations of polyatomic molecules, Rotation-vibration spectra of polyatomic molecules, Instrumentation of Infrared and Fourier Transform Infrared (FTIR) spectrometer.

Unit-II: **12Hrs**

Raman spectroscopy: Molecular polarizability, Quantum theory of Raman scattering, Pure-rotational Raman spectra, Vibrational Raman spectra, Rotational fine structure, Vibrations of Spherical top molecules, Structure determination from Raman and Infrared spectra, Instrumentation of Raman Spectrometer.

Electronic spectroscopy: Electronic spectra of diatomic molecules-Vibrational coarse structure, Franck-Condon principle, Dissociation Energy, Rotational fine structure of Electronic–vibration transitions.

Light Sources and Detectors: Synchrotron Radiation source, Dye Laser, Thermal Detectors, Photomultiplier Tube and Photodiode, Charge Coupled Detector (CCD), Identification of functional group.

Unit-III: **10Hrs**

Magnetic Resonance Spectroscopy: Magnetic properties of nuclei, Resonance condition, Classical theory and Bloch's equations, Relaxation processes-spin-lattice and spin-spin relaxations, chemical shift, NMR instrumentation, NMR Imaging.

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Electron spin resonance: Principles of ESR, Conditions for resonance, Spin Hamiltonian, Hyperfine structure, ESR spectra of Hydrogen atom, CH_3 radical and Benzene anion, Instrumentation of ESR spectrometer.

Unit-IV: **12Hrs**

Nuclear Qudrupole Resonance (NQR) Spectroscopy: Quadrupole nucleus, Principle of Nuclear quadrupole resonance (NQR), Half integral and Integral spins, Studies on chemical and hydrogen bonding and solid state applications, NQR spectrometer Instrumentation.

Mossbauer Spectroscopy: Recoilless emission and absorption of gamma rays. Isomer shift, Quadrupole interaction, Magnetic hyperfine interaction. Applications - Determination of electronic and molecular structure, Crystal symmetry and magnetic structure, Instrumentation of Mossbauer spectrometer.

Recommended Books:

1. Chemical applications of group theory **– F. A. Cotton**
2. Fundamentals of molecular spectroscopy **- *Colin N. Banwell and Elaine,*** TMH.
3. Molecular structure and spectroscopy - ***G Aruldhas,*** PHI.
4. Introduction to Molecular spectroscopy **- *Gordon M. Barrow,*** McGraw Hill.
5. Spectroscopy – Vol 1 and 2 **– *B P Straughan and S Walker,*** Chapman & Hall**.**
6. Principles of Magnetic resonance **– *C P Slitcher,*** Harper & Row NY J W Hill.
7. Electron Spin Resonance – ***Wertz and Bolton.***
8. Introduction to Mossbauer Spectroscopy – ***Ed by May L.***
9. Nuclear Quadrupole resonance spectroscopy **– *Das T P and Hahn E L.***
10. Laser Spectroscopy**- W. Demtroder.**

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4.3A. SOLID STATE PHYSICS – (SPECIAL – III)

Unit-I : **12Hrs**

Free electron theory of metals –Outstanding properties of metals**,** Electrical D.C conductivity, A.C conductivity and thermal conductivity, free electron concentration, properties of a degenerate Fermi gas at $7 > 0^0$ K, Free electron gas at 0^0 K, energy of electron gas at 0^0K Richardson –Dushman equation and experimental verification.

Unit-II : **12Hrs**

Energy bands and Fermi surface: Tight binding approximation, Wigner-Seitz approximation. deHaas-Van Alphen effect, cyclotron resonance, magneto resistance, Giant magneto resistance (GMR) and Colossal magneto resistance (CMR) materials and their applications – Spintronic devices.

Unit-III : **11Hrs**

Superconductivity–I: Experimental survey – occurrence of superconductivity, effect of magnetic field - Meissner effect , Type I, Type II super conductors, energy gap, Specific heat, isotope effect, Thermodynamics of the transition (I and II order) - entropy, specific heat, thermal conductivity, flux quantization supercurrents, vortex state.

Unit-IV : **13Hrs**

Super conductivity–II: London's equation, penetration depth, coherence length. Ginzburg – Landau theory – G- L equations. Single particle tunneling (N-I-N) (S-N-S), (S-I-S) Josephson tunneling – DC Josephson effect, DC- SQUID. Electron-phonon interaction –Cooper instability – Cooper pairs. BCS theory (Qualitative – ground state, results of BCS theory). High T_c superconductivity. Applications of superconductivity.

Recommended Books:

1. Introduction to Solid State Physics **–** ***C Kittel,*** John Wiley & Sons.
2. Material Science and Engineering **–** ***W D Callister,*** John Wiley & Sons.
3. Solid State Physics **–** ***N. Ashcroft and N.D. Mermin,*** Thomson Books.
4. Solid State Physics: Structure and Properties of Materials – ***M.A.Wahab***, Narosa
5. Quantum theory of Magnetism – ***W. Nolting and A. Ramakanth***, Springer
6. Principles of Nanomagnetism – ***Alberto P. Guimaraes***, Springer
7. Fundamentals of Solid State Physics –Saxena Gupta -Saxena

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4.3B ELECTRONICS – SPECIAL – III (Microcontrollers and Applications)

Unit-I : **12Hrs**

Microcontrollers and Embedded Systems: block diagram of 8051. Architecture of 8051 – Pin assignments. Program counter and Data pointer –Flags and PSW – Internal RAM – Special function Registers – Register banks and stack – I/O ports and circuits – External Memory – Counters and Timers – Serial Data I/O, Interrupts.

Unit-II : 13Hrs

Programming of 8051: Introduction, Addressing modes, instruction set and Assembly Language Addressing modes – Instruction set-Moving data – External Data moves, push and pop opcodes, Data Exchanges, Logical: Byte and Bit level operations Rotate and Swap operations, Arithmetic: Flags, Increment, Decrement, Addition, Subtraction, Multiplication and Division; JUMP and CALL Instructions: Jumps, Calls, subroutines, interrupts and returns. Programming examples.

Unit-III : **10Hrs**

Interfacing of peripherals to Microcontrollers: Interfacing of PPI 8255, LCD & Key Board with 8051. Interfacing of stepper motor, ADC, DAC and sensors with 8051. Interfacing to external memory.

Unit-IV : 13Hrs

Other Microcontrollers: Atmel Microcontrollers, Architectural details and pin description of Atmel 89C51 and 89C2051 microcontrollers. Using flash memory devices Atmel 89CXX and 89C20XX. Applications of Atmel 89C51 and 89C2051 Microcontrollers: generation of sine, square and staircase ramp waves, PIC Microcontrollers: Overview and features, PIC16C6X/7X, FSR (file selection register), PIC Reset Actions, PIC oscillator connections, PIC memory organization.

Recommended Books:

1. The 8051 Microcontroller **– *Kenneth Ayala***, DELMAR CENGAGE learning.
2. The 8051 Microcontroller and Embedded systems using Assembly and C **– *M.A.Mazidi, J,G.Mazidi and R.D.McKinlay*** – PHI.
3. Microcontrollers – Theory and Applications **- *A.V.Deshmukh***, TMH.
4. Programming and customizing the 8051 Microcontroller – ***Myke Predko*****,** TMH.

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4.3C. Nanoscience (Materials Science –II)

Unit-I: **12Hrs**

Phase Diagrams: Laws of thermodynamic functions, concept of free energy, stability and metastability, relative stability of phases and phase rule and phase diagrams solid solutions, limited and unlimited solid solubility, interstitial and substitutional solid solutions, Hume Rothery rules, Unary and Binary phase diagrams(Lead-tin and Iron –carbon phase diagrams) phase diagrams, lever rule, homogeneous and heterogeneous nucleation, growth and transformation kinetics, microstructural changes during cooling and heating, applications of phase diagrams.

Unit-II: **14Hrs**

Ceramics and Composites –Introduction to ceramics, classification of ceramics, Ceramic structures-oxide structures, silicate structures, ceramic phase diagrams-two oxide systems,– Brittle fracture of ceramics–stress-strain behaviour of ceramics, micro-structure of ceramics, grain growth in ceramics**. Composite materials:** Definition of composite materials, Reinforcement in composite materials. Fibres, types of fibres, laminar composites. Design of composite materials. Metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon-carbon composites, hybrid composites. Applications of composites.

Unit-III: **12Hrs**

Polymers - Classification of Polymers, polymer molecules, chemistry of polymer molecules, molecular weight, structure of polymers, formation of free energy of polymer system, Flory – Huggins free energies, phase diagrams in polymer blends, thermoplastics and thermosetting polymers, mechanical behaviour polymers-stress-strain behaviour, viscoelastic deformation, strengthening of polymers, crystallization, melting and glass transition phenomenon in polymers, polymerization, manufacturing of polymers, applications of polymers.

Unit-IV: **10Hrs**

Luminescence and Luminescent materials - General consideration of Luminescence, excitation, absorption and emission process of luminescence, Co-ordinate diagram, energy level diagram, radiative and non-radiative processes. Different types of Luminescence – Electroluminescence and Photoluminescence – Color centres – different kinds of color centers in alkali halides.

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Recommended Books:

1. Materials Science –**Raghavan,PHI**.
2. Material Science and Engineering by **RALLS COURTNEY WULFF**
3. Composite materials **–S.C.Sharma**
4. Materials Science and Engineering –**W.D.Calister,** JohnWiley and sons Inc
5. Introduction to Ceramics –**W.D.Kingery,H.K.Bowen and D.R.Uhlmann**, John Wiley and Sons.
6. Solid State Physicsv-**A.J.Dekker**, Macmillan India Ltd., 2003
7. Introduction to Ferroic Materials –**V.K.Wadhawan**
8. Luminescent materials –**G.Blasse and C.Grabmaier**, Springer-Verlog,1994

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4.4A. SOLID STATE PHYSICS – SPECIAL -IV

Unit-I : **10Hrs**

The Electronic Band structure of Solids: General symmetry properties, The Nearly Free-Electron approximation, Examples of Band structures, The Density of states, extended, reduced and periodic zone schemes, Density of states in Non crystalline solids, Photoemission spectroscopy.

Unit-II : **12Hrs**

Band structures of selected metals and methods for calculating band structures: Alkali metals, Noble metals, Divalent simple metals, Trivalent simple metals, semi metals, transition metals, rare earth metals and alloys.

Methods for calculating band structure: Independent electron approximation, General features of Valence band wave functions, Cellular method, Muffin-Tin potentials, Augmented plane wave (APW) method, Green's function (KKR) method, Orthogonal plane wave (OPW) method and Pseudo potential method.

Unit-III : **14Hrs**

Nano-structures: Electronic structure of 0D and 1D systems: Quantized energy levels 545 semiconductor nanocrystals metallic dots discrete charge states, One-dimensional(1D) sub bands, spectroscopy of Van Hove singularities 1D metals-coulomb interactions and lattice couplings.

Electrical Transport in 0D and 1D: Coulomb oscillations, spin, Mott insulators and the Kondoeffect Cooper pairing in superconducting dots. Conductance quantization and the Landauer formula, two barriers in series-resonant tunneling, Incoherent addition and Ohm's Law, Localization, voltage probes and the Buttiker-Landauer formalism.

Vibrational and Thermal properties: Quantized vibrational modes, Transverse vibrations,Heat capacity and thermal transport.

Unit-IV : **12Hrs**

Measuring the Fermi surface and Surface effects: Effect of electric and magnetic fields on Fermi surfaces**,** Magnetoacoustic effect, Ultrasonic effect, Anomalous skin effect, The work

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function, contact potentials, Thermionic Emission, Low energy electron diffraction, field ion microscopy and electronic surface levels.

Recommended Books:

1. Physical properties of crystals J.F.Nye
2. Physics of crystals S.Bhagavantam and S.Radhakrishna
3. Solid State Physics –Charles Kittle
4. Solid State Physics –Dekker
5. Solid State Physics –Structure and properties of Materials M.A. Waheb Narosa
6. Solid State Physics –Kachava
7. Principles of the Solid State –H.V.Keer
8. Crytal growth from liquids –J.C.Brice, North Holland Publishers
9. Intermediate theory of crystalline solids – Animalu
10. An introduction to principles of materials science –Harald Ibach 1 Hans Luth.
11. Solid State Physics – Ashcroft and Mermin
12. The Oxford solid state basics –Steven H.Simon
13. Nano structured materials and Nanotechnolofy –Hari Singh Nalwa.
14. Luminescent materials – G.Blasse and C.Grabmaier, Springer –Verlog, 1994

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4.4B: Electronics (Special – IV): Satellite and Mobile Communication

Unit - I: **12Hrs**

Satellite Communication - I: History of Satellites, Kepler's laws, Principles of Satellite orbits and positioning, Satellite Height, Speed, Angle of inclination, Geo synchronous orbits, Position coordinates in latitude and longitude, Azimuth and elevation, Repeaters and Satellite Transponders, Frequency allocations for Transponder channels, Spectrum usage, Frequency Reuse, Satellite Subsystems – Attitude and Orbit Control Systems, Communication Subsystems, Channelization process - Multi channel Architecture, Power Subsystems; Telemetry, Command and Control Sub-systems.

Unit-II: **12Hrs**

Satellite Communication - II: Ground station, Antenna Subsystems, Receive **S**ubsystems - Receive ground control equipment, Transmitter Subsystems – Transmit ground control equipment, Power Subsystems, Telemetry and Control Subsystems, Satellite Applications - Communication satellites, Digital Satellite Radio, Surveillance satellites, Global Navigation Satellite Systems - Space segment, Control segment, GPS receivers - GPS Triangulation, GPS Applications.

Unit-III: **12Hrs**

Introduction to Cellular Mobile Systems: Limitations of conventional mobile telephone system - Spectrum efficiency considerations, Technology feasibility and affordability; Trunking efficiency, Basic Cellular System, Performance criteria – Voice quality, Service quality, Special features, Operation of Cellular Systems, Planning a Cellular System – Regulations, Engineer's role and Finding solutions:

Unit-IV: **12Hrs**

Elements of Cellular Mobile Radio System: General Description – Maximum number of Calls per Hour, Maximum number of frequency channels per cell, Frequency Reuse Channels – Frequency reuse schemes, Frequency reuse distance, Number of customers in the system, Co-channel interference reduction factor, Handoff Mechanism, Cell Splitting, Personal Communication System (PCS) – Standards, 1G, 2G, 3G and 4G.

Recommended Books:

1. Electronic Communication Systems - ***Wayne Tomasi,*** 5th edition, Pearson Education.
2. Principles of Electronic Communication Systems – ***Louis E. Frenzel*** (3rd Ed.) MGH

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3. Principles of Communication Systems – ***H. Taub, D. L. Schilling, Goutam Saha*** (3rd edition), TMH
4. Satellite Communications - ***Timothy Pratt, Charless Bostian, Jeremy Allnutt,*** 2nd edition, Wiley.
5. Electronic Communications **–** ***Dennis Roddy and John Coolen***, Pearson Education.
6. Mobile Cellular Communications – ***William C. Y. Lee,*** 2nd edition, MGH.
7. Mobile Communications – ***Jochen H. Schille***

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4.4C. NANOSCIENCE – II

Unit-I: **14Hrs**

Characterization Techniques for Nanomaterials: Commonly used analytical techniques for characterization of nanomaterials. Electron Microscopes - Interaction of Electrons with Solids, Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Scanning Probe Microscopes (SPM) - Scanning Tunneling Microscope (STM), Atomic Force Microscope (AFM), Scanning Near-Field Optical Microscope (SNOM), Magnetic Force Microscope (MFM), X-ray diffraction techniques – Diffraction from different types of samples, Diffraction from nanoparticles, Magnetic Measurements – Vibrating Sample Magnetometer (VSM).

Unit-II: **10Hrs**

Properties of Nanomaterials: Mechanical properties, structural properties, Thermal properties, Electrical properties, Optical properties of metallic and semiconductor nanoparticles, Luminescence in semiconductor nanoparticles, Magnetic properties.

Unit-III: **12Hrs**

Carbon based Nanomaterials: Introduction to Carbon Clusters, Preparation and Characterization of Fullerenes and Graphene. Carbon Nanotubes (CNTs) – Types of Carbon nanotubes, Synthesis of Carbon nanotubes, Growth mechanism, Electronic Structure of Carbon Nanotubes, Properties and Applications of CNTs, Nanodiamond, Nanoelectronics – single electron transistor, molecular machine.

Unit-IV: **12Hrs**

Advanced Nanomaterials: Porous Silicon - Preparation: Electrochemical Etching method, Mechanism of pores formation, Properties and Applications of Porous Silicon. Aerogels - Types of Aerogels, Properties and applications of Aerogels. Zeolites- Synthesis, Properties and Applications. Ordered porous materials using micelles as templates. Self Assembled Nanomaterials - Inorganic and Organic molecules.

Recommended Books:

1. Nanostructured Materials and Nanotechnology – ***Hari Singh Nalwa***, AP.
2. Introduction to Nanotechnology – ***C.P. Poole Jr and F.J. Owens***, John Wiley and Sons Inc.

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3. Introduction to Nanoscience and Nanotechnology **– *K.K. Chattopadhyay and A.N. Benarjee,*** PHI.
4. Nanotechnology: Principles and Practices – ***Sulabha K Kulkarni***, Capital Publishing Company, New Delhi.
5. Instrumental Methods of Analysis –
6. Physical Principles of Electron Microscopy – ***Ray F Egerton***.

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4.6. General Physics-II Laboratory

1. Determination of susceptibility of a given salt using Quinke's tube method.
2. To study the characteristics of a given solar cell.
3. To verify Beer's law using spectrophotometer.
4. To determine the γ-attenuation coefficients for lead, copper, and aluminum using G M counter.
5. Analysis of hysteresis loop for a given ferromagnetic material and to determine its saturation magnetization, retentivity and co-ercivity.
6. Determination of numerical aperture of an optical fiber.
7. To study the characteristics of a given Laser Diode.
8. Analysis of an audio amplifier using optical fiber.
9. Resistivity measurement of thin slice conducting /non-conducting measurements using bottom surface method.

4.7A. Solid State Physics special-II Laboratory

1. Determination of the ferroelectric Curie temperature of $BaTiO_3$ Polycrystalline pellet.
2. Determination of the dispersion curves of monatomic and diatomic lattice analogs using Lattice Dynamic kit.
3. Estimation of colour centre density of X- ray irradiated alkali halide crystal using spectrophotometer.
4. Determination of photoelastic constants using Babinet compensator.
5. Determination of energy band gap of a semi-conductor thin film using spectrophotometer..
6. Determination of refractive index of a single crystal –Brewster angle method using He-Ne Laser.

4.7B. Electronics Special-II Laboratory
(Part-I: Microcontroller Experiments using 8051)

1. Program for multiplication of two Hexa decimal numbers.
2. 2. Program for division of two Hexa decimal numbers.
3. Programs to pick the smallest and largest numbers in a given set of numbers.
4. Programs for arranging given 'n' numbers in ascending and descending order.
5. Program for generation of specific time delay.
6. Program to interface a D A C and generate saw tooth, square and rectangular waveforms.
7. Program to flash an LED connected at a specified output terminal.

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8. Program to interface a stepper motor, rotate it in clockwise and anticlockwise through given angle steps.
9. Programming using Keil software.
    a) To pick the smallest among a given set of numbers.
    b) To pick the largest among a given set of numbers.
    c) To arrange a given set of numbers in an ascending order and descending order.
    d) To generate a rectangular waveform at a specified port terminal.

Part-II: Digital Communications:

1. Study of sampling techniques.
    a) Natural sampling.
    b) Sample and Hold.
    c) Flat top sampling.
2. Study of various sampling frequencies and Duty cycles.
3. Study of order of the low pass filter.
4. Study of TDM with different receiver and synchronization techniques.
5. Study of Pulse Code Modulation and Demodulation.
6. Study of various carrier modulation and demodulation techniques.
7. Study of Delta Modulation and demodulation.
8. (i) Study of continuously variable slope detector and modulation and demodulation (ii). Study of companding system .
9. (i) Study of pulse width modulation and demodulation.
   (ii) Study of pulse position modulation and demodulation.
10. Voice communication/Optical Fiber Communication.

4.7C. Nanoscience -II Practicals

1. To study the dielectric behavior of PZT ceramic by determining dielectric constant.
2. To prepare nanoparticles using Ball Milling.
3. DSC/DTA/TGA studies for the thermal analysis of materials
4. To draw the B-H loop of a ferromagnet.
5. Synthesis of CdS nanoparticles.
6. Synthesis of ZnO particles.
7. Synthesis of transition metal oxide nanoparticles by Solid-State Thermolysis.
8. Optical absorption of Silver nanoparticles by using UV-Vis Spectroscopy.
9. Synthesis of Carbon Nanotubes.

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