SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI

Syllabus Prescribed for Second Year 2023-24 PG Programme

Programme: M.Sc. Physics

Semester III

Subject	Code of the Course	Title of the Course	Credits	Total Number of Periods
DSC-VIII	3PHY -1	Statistical Mechanics	04	60
DSC-IX	3PHY -2	Atomic and Molecular Physics	04	60
DSE-II	3PHY -3 (i) (Elective)	Radiation and Plasma Physics	04	60
	3PHY -3 (ii) (Elective)	Spectroscopic Techniques	04	60
DSE-III	3PHY -4 (i) (Elective)	Digital Techniques	04	60
	3PHY -4 (ii) (Elective)	Condensed Matter Physics –I	04	60
	3PHY -4 (iii) (Elective)	Photonics –I	04	60
DSE-III (Lab)	3PHY -5 (i)	Lab on Digital Techniques	04	120
	3PHY -5 (ii)	Lab on Condensed Matter Physics –I	04	120
	3PHY -5 (iii)	Lab on Photonics –I	04	120
Research Project Phase-I	3PHY -6	Review report of proposed project work (Viva-voce)	04	120

3PHY-1: Statistical Mechanics

COs	After completing the course, students must be able to-
CO1	Understand the concept of microscopic and macroscopic states and relationship between thermodynamics and statistics; classify ensembles, relate partition function with thermodynamic quantities.
CO2	Discuss statistics of indistinguishable particles, application of Fermi-Dirac and Bose-Einstein distribution to these particles.
CO3	Interpret classical (Maxwell-Boltzmann) statistics and quantum statistics (Bose and Fermi Dirac) statistics for different systems of particles.
CO4	Discuss phase transition, transport phenomenon and correlate space - time dependent fluctuations.
CO5	Understand the concept of super-fluidity, Landau's theory and non-equilibrium processes.

Unit I	Classical Statistics: Specification of States, phase space, trajectory and density of states, Liouville's theorem, ensemble, micro canonical, Canonical and grand canonical ensembles, comparison of ensembles, Partition function and its correlation with thermodynamic quantities, Properties of partition function. Gibbs Paradox.	**12**
Unit II	Quantum Statistics: Basic Concepts regarding statistics of indistinguishable particles, Concepts about Fermi-Dirac and Bose-Einstein distribution. Ideal Bose-Einstein gas, degeneracy, Bose-Einstein condensation. Thermal properties of B-E gas. Blackbody radiation and Planck's distribution law.	**12**
Unit III	Ideal Fermi-Dirac Gas: Thermodynamic function of degenerate F-D gas, Free electron model and electron emission. Di-atomic molecule, specific heats of solids, Einstein & Debye theory	**12**
Unit IV	Phase Transitions: Landau's theory of phase transition, Fluctuation in Thermodynamic Quantities, Correlation of space - time dependent fluctuations, fluctuations and transport phenomena, Brownian motion and Random walk, The Fokker-Planck Equation and its solution.	**12**
Unit V	Introduction to non-equilibrium processes Diffusion equation. Super-fluidity, experimentally observed properties of super-fluid He II. Landau's theory.	**12**

Reference Books:

1. Statistical Mechanics, K.Huang, Wiley Eastern Limited.
2. Statistical Physics, Landau and Lifshitz.
3. Statistical mechanics, Donald Allan McQuarrie, University Science Books
4. Introduction to modern statistical mechanics, David Chandler, Oxford University Press.
5. Statistical Mechanics, B. K. Agarwal, New Age International.
6. Statistical mechanics, James Woods Halley, Cambridge University Press.

7. Statistical mechanics, Shang-keng Ma, World Scientific.
8. Statistical Mechanics, B.K.Agrawal and M.Eisner, Wiley Eastern Limited.
9. Introduction to Statistical Mechanics, B.B.Laud.
10. Statistical Mechanics, Gupta, Kumar, Pragati Prakashan, Meerut.

3PHY-2: Atomic & Molecular Physics

COs	**After completing the course, students must be able to-**
CO1	describe VAM and quantum numbers and understand spectroscopy of the hydrogen and alkali atoms
CO2	discuss of quantum behaviour of atoms in external electric and magnetic fields and recognize the spectroscopy of many electron atomic systems and hyperfine splitting of spectral lines
CO3	discuss Paschen Back effect, Stark effect, apply coupling schemes for two electron atoms and describe Resonance Spectroscopy (ESR and NMR)
CO4	be able to apply knowledge to detailed understanding of vibrational-rotational spectroscopy of diatomic molecules, isotope shifts and the detailed concept of Infrared and Raman spectra of Polyatomic molecules.
CO5	discuss the importance of rotational and vibrational energy levels by studying molecular spectroscopy.

Unit I	Vector atom model; Space quantization and spin of electron, significance of Principle quantum number (n), Orbital quantum number (l), Magnetic Orbital quantum number (m_l), Spin quantum number (s), Magnetic spin quantum number (m_s), Total Angular Momentum quantum number (j), Magnetic Total number (m_j). l-s coupling for single valence electron atom. Stern Gerlach Experiment. Pauli's exclusion principle. Spectra of alkali elements. Fine structure in alkali spectra.	**12**
Unit II	Normal and Anomalous Zeeman effect. Experimental setup to study Zeeman effect. Debye's explanation of Normal Zeeman effect. Theory of Anomalous Zeeman effect. Expression of Lande's spectroscopic splitting factor (g) and effective magnetic moment for single valance electron atom. Origin of Sodium D1 & D2 lines. Anomalous Zeeman effect in Sodium D1 & D2 lines.	**12**
Unit III	Paschen Back effect; Stark effect. LS & JJ coupling in two valence electron atoms. Interaction energy in LS & JJ coupling. Hyperfine structure (Qualitative), Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Born-Oppenheimer approximation.	**12**
Unit IV	Types of Molecules: Diatomic linear symmetric top, asymmetric top and spherical top molecules. Molecular (band) spectra. Classification of molecular spectra (pure rotational spectra, Rotation-vibration spectra, Visible and UV spectra), Rotational spectra of diatomic molecules as a rigid rotator. Quantum mechanical theory of pure rotational spectra (rigid rotator). Energy levels and spectra of nonrigid rotator. Comparison between spectra of rigid and nonrigid rotators. Isotopic effect in pure rotational spectra.	**12**

Unit V	Vibrational energy of Diatomic molecule. Diatomic molecule as a simple harmonic oscillator. Energy levels and spectrum. Morse potential energy curve. Molecules as a vibrating rotator. Vibration spectrum of diatomic molecule. PQR branches, Raman spectra of diatomic molecules; IR spectrometer (Qualitative).	**12**

Reference Books:

1. Physics of Atoms and Molecules: Bransden and Joachain.
2. Introduction to Atomic Spectra: HG Kuhn.
3. Spectroscopy Vol. -I,II & III - Walker & Straughen
4. Introduction to Molecular Spectroscopy - G.M.Barrow
5. Spectra of Diatomic Molecules - Herzberg8.Molecular
6. Spectroscopy - Jeanne L McHale
7. Molecular Spectroscopy - J.M.Brown
8. Spectra of atoms and molecules - P.F.Bemath
9. Modern Spectroscopy - J.M.Holias
10. Elements of Spectroscopy - Gupta, Kumar, Sharma, Pragati Prakashan, Meerut.
11. Introduction to Atomic Spectra- H.E.White
12. Fundamentals of Molecular Spectroscopy - C.B.Banwell

3PHY -3 (i): Radiation and Plasma Physics

COs	After completing the course, students must be able to-
CO1	discuss charged particle dynamics and radiation from localized time varying electromagnetic sources and the basic mathematical concepts related to electromagnetic vector fields.
CO2	discuss and solve wave equation for electric field and magnetic fields in free space.
CO3	be familiar with concepts of plasma physics and its relation with ordinary electromagnetics.
CO4	discuss the concept and application of wave guide, plasma and confinement and effect of magnetic field on electromagnetic wave.
CO5	Be familiar with the Magnetosonic and Alfven Waves

Unit I	Wave Equation for Electric and Magnetic Fields in free space, Wave Equations for Vector and Scalar Potential, Retarded and Lienard-Wiechert Potentials, Electric and Magnetic fields due to a Uniformly moving charge and an Accelerating Charge. Total power radiated and Angular Distribution of Power Radiated by moving charge with linear and circular acceleration, Cerenkov radiation, Radiation Reaction Force.	**12**
Unit II	Motion of charged Particles in Electromagnetic Field: Uniform E and B Fields, Nonuniform Fields, Diffusion Across Magnetic Fields, Time Varying E and B Fields, Adiabatic Invariants: First, Second and Third Adiabatic Invariants.	**12**
Unit III	Definition of plasma, concept of temperature, Debye Shielding, Plasma Parameters, Applications of plasma Physics. Relation of Plasma Physics to ordinary electromagnetics, Classical treatment of Magnetic Materials and Dielectric. Dielectric constant of Plasma. Fluid equations of motion, Equation of continuity, equation of state, Fluid drifts parallel and perpendicular o magnetic field.	**12**
Unit IV	Plasma Oscillations, Electron Plasma Wave, Ion waves, Plasma Approximation, Electrostatic electron oscillations perpendicular to B, Electrostatic Ion waves perpendicular to B, Electromagnetic wave without magnetic field, Electromagnetic waves perpendicular and parallel to static magnetic field B0.	**12**
Unit V	Cutoffs and resonances, Whistler mode and Faraday rotation. Hydromagnetic Waves: Magnetosonic and Alfven Waves, CMA Diagram. Reflection of radio waves from ionosphere, effect of collision on reflection, Appleton- Hartee Formula and Propagation through Ionosphere and Magnetosphere.	**12**

References:

1. Introduction to Electrodynamics by David J. Griffiths, Publisher: PHI Learning (2009)
2. Electrodynamics: J. D. Jackson.
3. Elecrodynamics: Gupta Kumar Singh, Pragati Prakashan.
4. Electricity and magnetism: Mahajan and Rangawala Tata Mc Graw–Hill,New York.
5. Electrodynamics: Laud New Age Publication.
6. Introduction to Plasma Physics: Francis Chen, Plenum Press.
7. Fundamentals of Plasma Physics: BittenCourt, Pergamon Press.
8. Plasma Physics: Plasma State of Matter, S. N. Sen. Prgati Prakashan.

3PHY -3 (ii): Spectroscopic Techniques

COs	After completing the course, students must be able to-
CO1	Discuss about interaction of electromagnetic radiations with mater and ultraviolet-visible spectroscopy and their applications.
CO2	Understand infrared spectroscopy and experimental applications to determine molecular structure.
CO3	Understand Raman Effect, principle of Raman spectroscopy, mechanism of Raman Effect, instrumentation required and Applications.
CO4	Understand the principal and theory of Mossbauer spectroscopy
CO5	Understand modern spectroscopic techniques such as EDS, EDAX, XRF and XPS.

Unit I	Ultraviolet and Visible Spectroscopy: electronic transitions, radiative processes, energy diagram, internal conversion, conical intersection, Frank Condon principle, Kasha's rule, structure determination, other applications.	**12**
Unit II	Infrared Spectroscopy: Principle, nomenclature of infrared spectra, theory required for IR spectroscopy, IR radiation sources, IR monochromators, IR detectors, modes of vibrations, position and intensities of absorption bands, potential applications of IR spectroscopy.	**12**
Unit III	Raman Spectroscopy: Introduction, principle, properties of Raman lines, difference between Raman spectra and infrared spectra, mechanism of Raman Effect, instrumentation, Applications.	**12**
Unit IV	Photoelectron spectroscopy: Introduction, principle, instrumentation, theory, applications. Mossbauer spectroscopy: Principle, theory, applications, instrumentation.	**12**
Unit V	Modern spectroscopic techniques: electron energy loss spectroscopy (EELS) energy dispersive x-ray spectroscopy (EDS/EDAX), X-ray fluorescence spectroscopy (XRF), X-ray photoelectron spectroscopy (XPS).	**12**

References:

1. H. Willard, L.L. Merritt, J.A. Dean, F.A. Settle, Instrumental methods of Analysis; HCBS Publishing New Delhi; 2004, 7th Ed.
2. C.N. Banwell and E.M. McCash, Fundamentals of Molecular Spectroscopy, Tata McGraw- Hill, New Delhi; 4 th Ed.

3. H. Gunzler & A. Williams; Handbook of Analytical Techniques, WILEY-VCH Verlag GmbH; 2001, 1st Ed.
4. Spectroscopy: Gurdeep R. Chatwal, Sham K. Anand, Himalaya Publishing House.
5. Analytical Electron Microscopy for Materials Science: D. Shindo T. Oikawa, Springer.
6. Fundamentals of Energy Dispersive X-ray Analysis: John C. Russ, Butterworth-Heinemann

3PHY -4 (i): Digital Techniques

COs	After completing the course, students must be able to-
CO1	Construct and describe the operations of basic logic gates.
CO2	Use the Boolean algebra for the combinational logic design.
CO3	design and discuss the operations of various digital devices such as converters, multiplexers, etc.
CO4	Discuss the operations of Flip – Flop, Shift Registers and counters.
CO5	Discuss the operations of various memory devices such as RAM, EPROM, EEPROM and their series and parallel expansion.

Unit I	Fundamental Digital Devices: The transistor as a switch Basic logical operation like OR, AND and NOT , ExOR, NAND, NOR Electronic Circuit operations using Various Logic Families devices like TTL(Std, Schotky, LP, HP), C-MOS, Comparison on Fan in Fan out, Propagation delays, voltage levels, power consumption packing density etc. Merits and Demerits. NOR and NAND devices as basic building blocks, Classification of Logic Circuits.	**12**
Unit II	Combinational Logic Design: Boolean algebra – Simplification of logic circuits Boolean algebraic methods, rules, limitations Demorgan's theorems -Exclusive OR gate, Simplification of logic circuits using K'Map Method and complementary K'Map min terms/max terms. Half Adder, Full Adder, 7483 IC, Adder-2-Subtractor, Arithmetic circuits for Binary Multiplier, Binary Divider.	**12**
Unit III	Devices and converters: Multiplexer : 2:1, 4:1, 8:1 and 16:1, De-multiplexer : 1:2:,1: 4, 1:8 and 1:16, Decoder IC 7445, 7447, 74138, Encoder hex key, ASCII key ,SSD display Devices, CK/CA SSD codes , Data selector etc. 2-Bit ALU,, 4-Bit ALU-74181.	**12**
Unit IV	Sequential Logic Design: Bi-stable Multivibrator, Flip - Flops : the RS Flip- Flop, JK Flip - Flop - JK master slave Flip - Flops - T Flip - Flop – D flip - Flop - Shift registers - SIPO, PISO, SISO, PIPO, Universal Shift operations using various ICs, Data latches, Controlled buffers, Unidirectional & Bidirectional controlled buffers. Counters Synchronous and Asynchronous and combination counters.	**12**
Unit V	Memory Devices: Concept of a memory cell using DFF, Working of the memorycell for each type Static and dynamic random access memories SRAM and DRAM, CMOS and NMOS, nonvolatile - NMOS, magnetic, optical and ferroelectric memories, charge coupled devices (CCD). Read- only Memory (ROM) and applications. Random Access Memory (RAM) and applications. Memory Organization, Memory Map, Memory devices classification and features, Programmable, OTP Memory,	**12**

	EPROM, EEPROM, Memory map, Designing memory organization, Serial Expansion, Parallel Expansion using 6264, 2764, etc.	

References:

1. Digital Electronics, Principles, Devices and Applications, Anil K. Maini, John Wiley & Sons Ltd (2007).
2. Modern Digital Electronics, 5^{th} Edn, R.P. Jain.
3. Principles Of Digital Electronics by K. Meena , PHI Learning
4. Digital Electronics: Theory And Experiments 2^{nd} Edition 2015 by Kumar, Virendra, New Age International (P) Ltd Publishers.

3PHY -4 (ii): Condensed Matter Physics -I

COs	After completing the course, students must be able to-
CO1	Discuss the concept of band theory using models and theorems functional materials from an experimental viewpoint, solid state theory and properties; classify different crystal lattice types and state its correlation with reciprocal lattice and crystal diffraction.
CO2	Describe the origin of magnetism in solids and discuss classical and quantum theories for the paramagnetic solids.
CO3	Discuss the properties and origin ferromagnetism in solids and related theories.
CO4	Describe the dielectric properties of insulators and polarization mechanisms, outline its application in day-to-day life
CO5	Explain basic concepts of superconductivity, its properties, important parameters related to possible applications

Unit I	Band Structure - Electron levels in periodic potential (Kronig Penny Model), Bloch theorem - statement and proof. Crystal momentum, number of orbital's in a band, band index and the concept of effective mass. Motion of electrons in bands, Reduced, periodic and extended zone schemes, Construction of Fermi surface. Nearly free electron model: qualitative proof for origin of gap in periodic potential and perturbation theory. Tight binding model: assumptions and applications to SC, FCC and BCC structures.	**12**
Unit II	Magnetism: Atomic Magnetic Moment, Larmor Precession, Diamagnetism: Classical and Quantum Theory, Paramagnetism: Origin of permanent magnetic moment, Ideal Magnetic Gas, Classical and Quantum Mechanical Treatments of Paramagnetism, Paramagnetism in rare earth ions, Paramagnetic cooling.	**12**
Unit III	Ferromagnetism: Weiss Theory, Heisenberg Model of Molecular Field Theory, Spin Waves And Magnons, CurieWeiss Law, Theory of Ferri and Antiferro Magnetism, Domains And Domain Walls.	**12**
Unit IV	Dielectrics: Concept of dielectrics, Macroscopic and Local electric fields, Claussius. Mosotti relation, Types of Polarization mechanisms, complex dielectric constant, relaxation time, Concept of Ferroelectricity, Theories of ferroelectricity, Antiferrolectricity, Piezo electricity.	**12**
Unit V	Superconductivity: Introduction, Meissner effect, D.C. resistivity, the heat capacity, flux quantization, Type I and II superconductors. Superconducting energy gap, coherence length, London penetration depth, BCS theory, Ginzsberg- Landau theory, DC and AC Josephson effects, SQUID, Introduction to high Tc superconductors.	**12**

References:

1. Solid State Physics, N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd, 2009).
2. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).
3. Introduction to Solids, L V Azaroff (Tata-McGraw Hill, 1984).
4. Introduction to Modern Solid State Physics, Yuri M Galperin.
5. Solid State Physics, R. L.Sighal, Ram Nath Kedar Nath & Co., Publishers Meerut

3PHY -4 (iii): Photonics -I

COs	After completing the course, students must be able to-
CO1	Discuss the significance of Maxwell equations in electrodynamics, EM wave, radiation; understand fundamentals of geometric optics.
CO2	Discuss and apply the fundamentals of modern optics.
CO3	Discuss and apply the concept fourier optics; understand the concept holography.
CO4	Discuss and apply the concept near field optics; evanescent waves.
CO5	Discuss the radiation pressure of laser light, optical tweezers and concept of atom laser.

Unit I	Maxwell's equations, Maxwell's wave equations for a vacuum, solution of the general wave equation, Group and Phase velocity, generalized solution of the wave equation, transverse electromagnetic wave, flow of electromagnetic energy, electric dipole radiation, Fundamentals of geometrical optics, Ray tracing, paraxial approximation, Aberrations, Designing Optical set-ups, Thin lens theory	**12**
Unit II	Fundamentals of Modern Optics: Wave propagation, wave particle duality, Kramers - Kronig relations, Electromagnetic fields in homo and inhomogeneous dispersive media, diffraction theory, Polarization of light.	**12**
Unit III	Fourier Optics: Plane waves, spatial frequency, Optical Fourier Transform, Diffraction of light, special function in Photonics and their Fourier transform, convex lens and its function, Image formation, spatial filters, Holography, Applications of Holography.	**12**
Unit IV	Near Field optics: The evanescent waves, Goos-Hänchen Shift, generation of evanescent waves, Photon tunnelling microscope, scanning near field optical microscope, probes to detect the evanescent field.	**12**
Unit V	Radiation pressure of laser light, Optical Tweezers and its applications, Raman-optical tweezers, Laser cooling of atoms, Bose Einstein Condensate, Atom laser.	**12**

References:

1. Keigo Iizuka, "Elements of PHOTONICS Vol. 1 (In free space and special media) and 2 (for fiber and integrated optics)," Wiley Series in Pure and Applied Optics.
2. Eugene Hecht, "Optics (International Edition)," Addison Wesley, (2003).

3. F G Smith, T A King and D Wilkins, “Optics and Photonics: An Introduction,” John Wiley & Sons, Ltd, San Francisco, USA, (2007).
4. David J. Griffiths, “Introduction to Electrodynamics (3rd edition),” Pearson Publishers.
5. Born and Wolf, “Principles of Optics: Electromagnetic Theory of Propagation, Interference and Diffraction of Light,” Cambridge University Press.
6. Joseph W Goodman, “Introduction to Fourier Optics,” McGraw-Hill.
7. Hand Book/Optics, Vol. 1-IV, Optical Society of India, McGraw Hill.

3PHY -5 (i): Lab Course on Digital Techniques

It is necessary to perform atleast ten experiments from the list given below.

1. Digital I: Basic Logic Gates, TTL, NAND, and NOR.
2. Digital II: Combinational Logic.7483, BCD Adder, A-2-S
3. Designing various binary counters using JKMSFF.
4. Designing various Shift resisters using JKMSFF
5. Study of Multiplexer : 2:1, 4:1, 8:1 and 16:1, De-multiplexer : 1:2:,1: 4,1:8 and 1:16, Multiplexers and De-multiplexers.
6. Designing Memory using ICs of required organization Solving problems using K'Map
7. Design consideration of Combinational logic design circuits for HA/FA/ Subtractor,
8. Design consideration of Multiplier, Divider etc using ICs.
9. Design consideration of Synchronous/asynchronous Modulo N Counters and Decade Counter.
10. Design consideration of SIPO, PISO, SISO, PIPO, Universal Shift operations.
11. Design consideration of, Memory expansion problems.

Some Experiments based on 3PHY-1, 3PHY-2 and 3PHY-3 may be performed in addition to above list.

3PHY -5 (ii): Lab Course on Condensed Matter Physics

It is necessary to perform atleast ten experiments from the list given below.

1. Determination of Magnetic Susceptibility of Material by Quincke's Method.
2. Study of Magnetic Properties (Coercivity, retentivity, saturation magnetization and hysteresis loops) of ferromagnetic samples (soft iron, hard steel & nickel).
3. To study variation of Dielectric constant of a given solid / liquid with temperature.
4. Determinations of specific heat of graphite sample.
5. Determination of magnetic susceptibility of a solid by Guoy balancemethod.
6. Determination of Curie temperature of a given sample.
7. Determination of Lande's g-factor of DPPH using Electron Spin Resonance Spectrometer.
8. Determination of band gap of semiconductor by variation of conductivity with temperature.
9. Determination of band gap by absorption coefficient measurement.
10. Demonstration of Meissner effect.
11. Determination of adiabatic compressibility of a given liquid.
12. Determination of Thermoelectric Power of a substance.

Some Experiments based on 3PHY-1, 3PHY-2 and 3PHY-3 may be performed in addition to above list.

3PHY -5 (iv) Lab on Photonics-1

It is necessary to perform atleast ten experiments from the list given below.

1. Handling, cleaning, maintenance of optical components and laser systems. Laser safety demonstration.
2. Characterization of laser beam.
3. Setting up of two and multi-beam Interferometer.
4. Measurement of UV-Visible Absorption spectra of standard samples.
5. Measurement of refractive index of the transparent material using Mach-Zahnder Interferometer.
6. Conversion of continuous wave laser into pulsed laser.
7. To study relaxation oscillation of diode laser.
8. Temporal pulse shaping of laser beam.
9. To study various polarized states of light.
10. To record and study Laser Induced Breakdown spectroscopy signal of known and unknown samples.**(Demo)**
11. Setting up of high power interferometer demonstrative experiment.

Some Experiments based on 3PHY-1, 3PHY-2 and 3PHY-3 may be performed in addition to above list.

Syllabus Prescribed for Second Year 2023-24 PG Programme

Programme: M.Sc. Physics

Semester IV

Subject	Code of the Course	Title of the Course	Credits	Total Number of Periods
DSC-X	4PHY 1	Nuclear and Particle Physics	04	60
DSC-XI	4PHY 2	OPAMP Theory and Applications	04	60
DSE-IV	4PHY 3 (i) (Elective)	Nano-science and Nanotechnology	04	60
	4PHY 3 (ii) (Elective)	Advance Microprocessors and Microcontrollers	04	60
DSE-V	4PHY 4 (i) (Elective)	Microprocessor Programming and Interfacing	04	60
	4PHY 4 (ii) (Elective)	Condensed Matter Physics –II	04	60
	4PHY 4 (iii) (Elective)	Photonics –II	04	60
DSE-III (Lab)	4PHY -5 (i)	Lab on Microprocessor Programming and Interfacing	04	120
	4PHY -5 (ii)	Lab on Condensed Matter Physics -II	04	120
	4PHY -5 (iii)	Lab on Photonics -II	04	120
Research Project Phase-I	4PHY -6	Final project report submission (Presentation)	04	120

4PHY-1: Nuclear and Particle Physics

COs	After completing the course, students must be able to-
CO1	Understand the structure of atomic nuclei and basic properties of a nucleus such as binding energy and nuclear forces, the experiments to measure nuclear magnetic moment by Rabi's method and Block's method
CO2	Interpret ground state properties of Deuteron, discuss Meson Theory of Nuclear forces, beta decay and parity violation in the beta decay process.
CO3	Understand the concept of neutron physics, neutron energy sources and detectors.
CO4	Understand the process in particle detection and accelerations; identify and differentiate different nuclear detectors and particle accelerators.
CO5	Classify elementary particles and understand interaction between them.

Unit I	General Properties of Atomic Nucleus: Nuclear charge, Nuclear Mass,(Atomic Number and Mass Number), Meaning of isotopes, Isobars, Isotones, Isomers, Isodiapheres with examples, Nuclear Radius, Classification of Nuclear radius, (Electrical and Potential Radius)Determination of Nuclear Radius by electron scattering(Hofstadter's Experiment),Mirror Nuclei method, Mass Defect, Binding energy, Variation of Binding energy per nucleon with mass number, Semi empirical Mass Formula, Mass Parabola. Quantum Numbers for individual nucleons (Principal, Orbital, Radial, Spin, Total, Iso-spin, Quantum Numbers) Parity, Quantum Statistics; Nuclear Angular Momentum, Nuclear Magnetic Momentum, Nuclear Magnetic Dipole Moment, Measurements of nuclear magnetic moment by Rabi's method and Block's method, Problems.	**12**
Unit II	Nuclear Forces: Deuteron, Ground state properties of Deuteron (Properties of Nuclear Forces, number, Range and depth of potential, excited States of Deuteron), Neutron-Proton scattering at low energies (Scattering length, phase shift, spin dependence, Coherent scattering ,shape independent effective range theory; Proton-Proton scattering at low energies, similarity between n-n and p-p forces ,Meson Theory of Nuclear forces ,spin dependence of Nuclear forces. Beta Decay and Nuclear Models: Three forms of β decay, continuous nature of β-ray energy spectrum, difficulties encountered in explaining β-ray energy spectrum, Pauli's Neutrino hypothesis (properties of neutrino and explanation of β-decay using Pauli's Neutrino hypothesis), Assumption of Fermi's theory of β-decay, Fermi-Kurie Plots, Seargents Plots. Detection of Neutrino (Cowan Experiment), non-conservation of Parity in β-decay (Wu's experiment). Liquid drop model of Nucleus, Magic numbers, Evidences in support of Magic Numbers, Shell Model.	**12**

Unit III	Neutron Physics, Properties of neutrons, classification of neutrons according to their energy, neutrons sources, neutrons detectors, slowing down of fast neutrons, absorption of neutrons. Reactor Physics: neutrons multiplication, types of reactors, General considerations for reactor design, four factor formula, moderators.	**12**
Unit IV	Nuclear Detectors - Gas filled, solid state and high energy detectors. Wilson cloud chamber, Spark Counter. Particle Accelerators - Need for particle accelerators, classification, wave guide type linear accelerator, focusing in linear accelerators, Betatron, Synchrotron, Synchrotron as a radiation source.	**12**
Unit V	Particle Physics: Classification of elementary particles, types of interactions between elementary particles, symmetry and conservation laws, Basic ideas of CP and CPT invariance, the quark model, Lie algebra, SU(2) and SU(3) multiplets (Meson and Baryon states), the General model.	**12**

Reference Books:

1. Nuclear Physics, Second Edition - Irving Kaplan, Addison-Wesley Publishing - Massachusetts.
2. Concepts of Nuclear Physics - Bernard L.Cohen, Tata McGrawHill Publishing Co. - New Delhi.
3. Elements of Nuclear Physics - Pandya M.L.
4. Nuclear Physics : An Introduction - S.B.Patel, Wiley Eastern LimitedNew Delhi.
5. Nuclear Physics : Theory and Experiment : R.R.Roy and B.P.Nigem,New Age International (P) Ltd.-New Delhi.
6. Nuclear Physics - D.C.Tayal, Himalaya Publishing House, Bombay.
7. Nuclear Physics - S.N.Ghoshal, S.Chand & Company, New Delhi.
8. Elementary - Particle Physics - Committee on Elementary Particle Physics Universities Press (India) Ltd., Hyderabad.
9. The Elements of Nuclear Reactor - Glasstone Samuel, D.Van Nestrand Company-New Jersey.

4PHY-2: Op-Amp Theory and its Applications

COs	After completing the course, students must be able to-
CO1	discuss the designing, operation and parameters of differential amplifier.
CO2	discuss the block diagram, parameters and applications of operational amplifier.
CO3	describe the parameters of op-amp and circuit to determine these parameters.
CO4	design the signal generators, oscillators and low and high pass first and second order filters.
CO5	understand and design multi-vibrators, ADC and PLL circuits.

Unit I	Differential amplifier - circuit configurations, Four types, DC analysis-AC analysis – Detail study of dual input balanced output differential amplifier -inverting and noninverting inputs CMRR- constant current bias level translator.	**12**
Unit II	Block diagram of a typical Op-Amp -Analysis Open loop configuration inverting and non-inverting amplifiers. Opamp with negative feedback - voltage series feedback - effect of feedback on closed loop gain input persistence output resistance bandwidth and output offset voltage - voltage follower.	**12**
Unit III	Practical op-amp Op-Amp parameter definition and illustration, input offset voltage - input bias current – input offset current offset voltage, CMRR, frequency response. DC and AC amplifier; summing, scaling and averaging amplifiers, instrumentation amplifier, integrator and differentiator.	**12**
Unit IV	Oscillators principles - Oscillator types - frequency stability - response - The phase shift oscillator. Wein bridge oscillator, LC - tunable oscillators - Multivibrators - Monostable and Astable – comparators. PLL circuit and its applications. OPAMP as butter worth filter (low pass, high pass and band pass only).	**12**
Unit V	Analogue computation, active filters, comparators, logarithmic and anti-logarithmic amplifiers, sample and hold amplifiers, waveform generators, Square and triangular wave generators, pulse generator. Applications of Linear ICs OPAMP as instrumentation amplifier, Digital to Analogue converter: ladder and weighted register type. Analogue to Digital converter : Counter type and successive approximation type.	**12**

Reference Books:

1. Op-Amps and Linear Integrated Circuits- Gaikwad R. A. : Prentice – Hall of India Pvt. Ltd.
2. Electronic Devices and Circuits, Vol. II – Godse A. P. and Bakshi U. A., Technical Publications, Pune.

4PHY-3 (i): Nano-science and Nanotechnology

COs	After completing the course, students must be able to-
CO1	understand the concept of free electron theory and 1D, 2D, 3D nanomaterials, band structure in three dimensions.
CO2	understand various chemical and physical methods for the synthesis of diverse types of nanomaterials (0D, 1D and 2D); derive information on the specific details of both bottom up and top-down synthesis
CO3	understand working principles and analysis of size, topography and morphology analysis of nanomaterials based on SEM/TEM and scanning probe microscopies (AFM and STM).
CO4	describe the size dependent properties of nanostructured materials using the concept of quantum confinement and summarize their electrical and mechanical properties.
CO5	acquire the knowledge of carbon nanostructures and illustrate their potential applications.

Unit I	Free electron theory and its features, Idea of band structures, Insulators, semiconductors and conductors, Reciprocal space, Energy bands and gaps of semiconductors, Effective masses, Fermi surfaces, Localized particles, The Bloch theorem, band structure in three dimensions. Electron transport in semiconductors in 3D (bulk), 2D (thin film) and low dimensional systems.	**12**
Unit II	Different methods for preparation of Nanostructured materials, Bottom up and top-down process, sol-gel, electrode deposition, chemical bath deposition, thermal evaporation methods, ball milling, pulsed laser deposition, chill block melting and gas quantization method.	**12**
Unit III	Different methods for measuring the properties of Nanomaterials, Structure determination: Atomic structures, crystallography and powder diffraction method, determination of particle size from XRD peaks. Microscopy: Transmission electron microscopy, Field ion microscopy, scanning microscopy.	**12**
Unit IV	Size dependent properties, quantum size effect, quantum dot, quantum wire and quantum well. Mechanical and electrical properties of nano-structured materials, single electron tunneling, infrared detectors, quantum dot lasers. Super Conductivity at Nano Scale. Hopping conduction, Polaron conduction.	**12**
Unit V	Carbon nanostructures, nature of carbon bond, carbon clusters: C 60, Structure of C60 carbon nanotubes, Applications of carbon nanotubes: computers, fuel cells, chemical sensors, catalysis, Single electron transistor (no derivation), Molecular machine, applications of nanomaterials in energy, medicine and environment.	**12**

Reference Books:

1. Introduction to Nanotechnology – C. P. Poole, John Wiley and Sons
2. Nanotechnology Appin. Lab BPB publication New Delhi
3. Nanomaterials – A. K. Bandyopodhyay , New Age Publication
4. Physics of semiconductor nanostructures K. P. Jain Narosa Publication
5. Nanotechnology, Rakesh Rathi, S Chand & Company, New Delhi
6. Introduction to Nanoscience & Nanotechnology by K. K. Chattopadhyay and A.N. Banerjee, Publisher: PHI Learning and Private Limited.

4PHY-3 (ii): Advanced Microprocessor and Microcontroller

COs	After completing the course, students must be able to-
CO1	describe 8086 microprocessor, architecture, hardware, pin diagram, interface, modes of operation, memory addressing, address decoding and memory system design.
CO2	write and execute 8086 assembly language programming.
CO3	describe 8051 microcontroller architecture, hardware, interfacing, memory, I/O pins and interrupts.
CO4	write and execute 8051 microcontroller assembly language programming.
CO5	build I/O interfacing for 8051 microcontroller.

Unit I	8086 Microprocessors: Architecture and organization of 8086 microprocessors family, bus interface unit, 8086 hardware pin signals, timing diagram of 8086 family microprocessors, simplified read/ write bus cycles, 8086 minimum and maximum modes of operation, 8086 memory addressing, address decoding, memory system design of 8086 family, timing considerations for memory interfacing, input/output port addressing and decoding, introduction to 8087 floating point coprocessor and its connection to host 8086.	**12**
Unit II	8086 assemble language programming: Addressing modes, 8086 instruction formats and instruction set, data transfer, arithmetic, bit manipulation, string, program execution transfer and program control instructions, machine codes of 8086 instructions, assemble language syntax, assembler directives, initialization instructions, simple sequential and looping programs in assemble language, debugging assembly language programs.	**12**
Unit III	The 8051 Architecture : 8051 microcontroller, Hardware – oscillator, clock, program counter, data pointer, A and B CPU registers, Flags and the program status word (PSW), Internal memory, Internal RAM , the stack and stack pointer, special function register (SFR), internal ROM. I/O pins, ports and circuits External memory, counters and Timers serial data input/output, Interrupts.	**12**
Unit IV	8051 Assembly Language Programming Introduction , structure of assembly language, assembling and running on 8051 program, Data transfer types , addressing modes, PUSH and POP operations, Arithmatic, Logic , JUMP, LOOP, CALL instructions, time delay, I/O programming, serial port programming.	**12**
Unit V	Applications : Interfacing of LCD, Keyboard, ADC, DAC and Sensor interfacing. Microcontroller Application Development Tools : Use of Kell software 8051 development tool.	**12**

Reference Books:

1. The 8051 Microcontroller and embedded system using assembly and C - Mazidi, Mazidi Mckinlay
2. The 8051 Microcontroller – Ayala - third edition.
3. Microcontroller – Architecture, Programing, Interfacing and system design – Rajkamal 4 8051 Microcontroller – Mckenzie.
4. Microprocessors & Interfacing – Programming & hardware By D. V. Hall (TMH)
5. The 8088 AND 8086 microprocessors By Walter A. Trebel & Avtar Singh (PHI)
6. 8086 Microprocessor By Uffenbeck (PHI)
7. The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium and Pentium Pro Processor Architecture, programming and interfacing. By Barry B. Brey (PHI)
8. The 8051 Microcontroller: Architecture, programming and applications By Kenneth J. Ayala (Penram International)
9. The 8051 Microcontroller and Embedded Systems By Mazidi & Mazidi (PHI)

4PHY-4 (i): Microprocessor Programming and Interfacing

COs	After completing the course, students must be able to-
CO1	describe 8085 microprocessor, architecture, blocks, basic instruction set.
CO2	write and execute 8085 assembly language programs.
CO3	build I/O interfacing for 8085 microprocessor.
CO4	understand and build programmable interface with peripheral devices.
CO5	describe interrupt structure of 8085.

Unit I	8085 Microprocessor: Basic 8085 microprocessor architecture and its functional blocks, 8085 microprocessor clock signals, address, data and control buses, instruction cycles, machine cycles, and timing states, Basic instruction set, instruction timing diagrams.	**12**
Unit II	Programming of 8085 microprocessor: HLL, LLL and ALP Writing assembly language programs, looping, counting and indexing operations, stacks and subroutines, conditional call and return instructions, debugging programs.	**12**
Unit III	8085 Interfacing: Bus interfacing concepts, timing for the execution of input and output(I/O) instructions, I/O address decoding, memory and I/O interfacing memory mapped I/O interfacing of matrix input keyboard and output display, Serial I/O lines of 8085 and the implementation asynchronous serial data communication using SOD and SID lines.	**12**
Unit IV	Programmable Interface and peripheral devices: PPI IC 8255A programmable peripheral interface Block Diagram, Control words, Modes of Operations and applications, 8251 SIO, USART block diagram functions. 8279 programmable keyboard/display interface controller.	**12**
Unit V	8253/8254 programmable interval timer, Interrupt structure of 8085: RST(restart) instructions, vectored interrupt, interrupt process and timing diagram of interrupt instruction execution, 8259 A interrupt controller, principles block transfer(direct memory access) techniques 8257 direct memory access controller.	**12**

Reference Books:

1. Microprocessor, Architecture, Programming and Application with 8085-Gaonkar, John Wiley Eastern , Ltd, Publication
2. Microprocessors and interfacing-Douglas V Hall, Tata Mc-Graw Hill publication

3. Microcomputer Systems: The 8086/8088 family-Yu-Chen Lin, Glen A Gibson, Prentice Hall of India Publication
4. The 8086 Microprocessor : programming and interfacing the PC, Kenneth J Ayala, Penram publication
5. The 8086 family: John Uffenbeck, Prentice Hall of India publication.

4PHY-4 (ii): Condensed Matter Physics - II

COs	After completing the course, students must be able to-
CO1	identify different type of defects and imperfections in crystals.
CO2	explain various dislocations and stacking faults in close packed structures by experimental methods.
CO3	interpret the Hartee & Hartee-Fock approximation; understand the basics of Fermi Liquid Theory.
CO4	describe different types of point defects within the frame work of band model.
CO5	identify different types of lattice disorders applying theoretical models, summarize impurity band semiconductor and amorphous semiconductors.

Unit I	Imperfections in Crystal: Mechanisms of plastic deformation in solid, Dislocations, stress & strain field of screw dislocation, elastic energy of dislocations, Slip, Cross slip, climb, Dislocation Multiplications, stress needed to operate Frank Read Source.	**12**
Unit II	Dislocation reaction, Partial Dislocations and stacking faults in close packed structures, Thompson Tetrahedron. Experimental methods of observing dislocation and stacking fault.	**12**
Unit III	Interacting electron gas, Hartee & Hartee-Fock approximation, Correlation energy, Screening, dielectric function, Thomas-Fermi and Lindhard Theory, Frequency dependent Lindhard screening, Screening of Hartee-Fock approximation. Introduction of Fermi Liquid Theory.	**12**
Unit IV	Point Defects: Types of point defects, concentration of point defects, description of point defect within the frame work of band model, diffusion and ionic conduction, recombination process of imperfection, optical transitions at imperfections.	**12**
Unit V	Lattice disorders: Types of lattice disorders, localized states, Anderson model, and density of states: Impurity band semiconductor, amorphous semiconductors, transport in disordered lattice, hopping probability, fixed and variable range hopping, conductivity in impurity bands and in amorphous semiconductors.	**12**

Reference Books:

1. Introduction to Dislocations, Derek Hull and D J Bacon, ButterworthHeinemann.
2. Introduction to Solid-State Theory, Otfried Madelung, Springer.
3. Solid State Physics, N W Ashcroft and N D Mermin (Cenage Learning India Pvt Ltd, 2009).
4. Introduction to Solid State Physics, C. Kittel (John-Wiley, 8th Ed. 2005).

4PHY-4 (iii): Photonics - II

COs	After completing the course, students must be able to-
CO1	discuss details about optical fiber, their classification, fabrication techniques and applications.
CO2	describe optical communications, optical transmitters, optical receivers, system design and performance.
CO3	discuss fundamentals of optical amplifiers, dispersion compensation and optical signal processing.
CO4	discuss about optical devices, optical modulators, optical transducers, optical switches, optical logic gates, photonic circuits, and optical sensors.
CO5	understand design, working and applications of optoelectronic devices like light emitting diodes (LED's), Diode lasers, fiber lasers and wave division multiplexing network optical devices.

Unit I	Optical fibers: Classification, total internal reflections, Goos Hanchen shifts, Analysis of optical wave guidesray and wave optics, characteristic equation of step index fiber, modes and their cut-off frequencies, single and multimode fibers, linearly polarized modes, power distribution.	**12**
Unit II	Graded index fiber, propagation constant, leaky modes, power profiles, dispersions, impulse response, types of couplings, Birefringent effects, polarization maintaining fibers, Fabrication techniques, Photonic crystal fiber.	**12**
Unit III	Optical Communications: Optical transmitters, Optical receivers, system design and performance, coherent and multi channel light wave systems, optical amplifiers, dispersion compensation, Optical signal processing.	**12**
Unit IV	Optical devices: Optical modulators, Optical Transducers, Optical switches, All optical logic gates, Photonic circuits, Optically integrated devices, Optical sensors.	**12**
Unit V	Optoelectronic devices: Wide bandgap semiconductors, light emitting diodes (LED's), Diode lasers, fiber lasers, Wave division multiplexing network optical devices, Advances in waveguides and waveguide devices, Plasmonic waveguides.	**12**

Reference Books:

1. Ajoy Ghatak and K Thyagarajan, "Introduction to fiber optics," Cambridge University Press (1999).

2. G P Agarwal, “Fiber-Optic Communication systems (second edition),”
3. Pallab Bhattacharya, “Semiconductor Optoelectronic devices,” Prentice Hall (1996).
4. Shun Lien Chuang, “Physics of Optoelectronic Devices,” Wiley Series in Pure and Applied Optics, John Wiley & Sons Ltd. (1995).
5. S. O Kasap, “Optoelectronics and Photonics: Principles and Practices,” Pearson Education (2001).

4PHY-5:
(A) Compulsary lab experiments: Experiments based on OP-AMP

1. Application of OPAMP as inverting, non-inverting amplifier, adder and subtractor.
2. Applications of OPAMP as differentiator and integrator.
3. OPAMP as square and triangular waveform generator.
4. OPAMP as instrumentation amplifier for measurement of temperature.
5. Study of ADC and DAC.
6. Study of PLL and its applications.
7. OPAMP as Butterworth filter low pass, high pass and band pass circuit.
8. ADC using ICsDAC using opamp and WRM, R-2-R Ladder
9. Design consideration of ADC/DAC Using Op-amp and other ICs
10. Digital Clock using Counters, Frequency meters.

(B) Respective laboratory on electives:

(i) Microprocessors Lab

It is necessary to perform atleast seven experiments from the list given below.

1. Experiment :Problem 1
   (A) 4 single byte numbers are stored at consecutive memory location starting at "X" write and implement a program which will transfer first two numbers in BC pair and the other two in DE pair respectively."
   [a] Using LDA instruction. [b] Using LHLD instruction. [c] Using register-indirect instruction. [d] Compare these programs in the context of memory requirements.
   (B) 4 single byte numbers are stored in registers B,C,D & E respectively. Write and implement the programme which will transfer the contents of the registers B,C,D,E to the memory block starts at X successively, respectively.
   [a] Using STA instruction. [b] Using SHLD instruction. [c] Using register indirect instruction. [d] Compare these programs in the context of memory requirements.
   (C) Two double byte nos. are stored at two memory location starts at X & Y resply. Write and implement the program which exchanges the information between X & Y resp.[i.e. X—Y & X+1—Y+1]
   [a] Using direct instructions {LDA}. [b] Using register indirect instruction. [c] Using LHLD & XCHG instruction. [d] Compare these programs in the context of memory requirements.
   (D) 4 single byte nos. are stored consecutively in memory starting at "X". Write and implement a programs
   [a] Using register indirect instruction, without loop. [b] Using forming loop i.e. branch control group instruction. [c] Compare the program in the context of memory requirements.
2. Experiment Problem 2:

(A) The 4 numbers are N1=F7, N2=6A, N3=32, N4=1C. Write a programme which will perform following arithmatic. store the result in some memory location [N1-N2] + [N3-N4].
[a] Using immediate instruction. [b] Using register indirect instruction [assume in this case nos. are stored consecutively in memory starting at "X")
[c] Optimise the programme.

(B) Two 5-byte nos. are stored at "X" & "Y" memory blocks.
Write a programme to substract the lower number from the higher number and stores a result in memory block starts at "Z"
[a] Using register indirect instruction without loop. [b] Using loop [i.e. branch control group instruction] [c] Optimise the programme.

(C) Two double byte decimal nos. are stored at memory locations X & Y resply. Write a programme which will obtain product of these two nos. in decimal equivalent and stores a result at Z.

3. Experiment Problem 3
   (A) Write a programme which will display "HELP" in freely running fashion.
   (B) Write a programme for Hexadecimal counter which will count the nos. from 00 to 40 and stops after. Implement a delay of 1 sec. and display the counts in data field.
   (C) Write a programme which will produce blinking display alternately of following words." "Hallow" & "Welcome"
4. Experiment Problem-4
   (A) Write programme for Hexadecimal counter which will count nos. from 0 to 21 and stops after. Implement a delay of 1.5 sec. and display the counts in data field of display.
   (B) Write a programme which will display your name, father's name & surname. "Come in Lab." alternatly. Implement a delay of 2 sec.
5. Experiment Problem-5
   (A) Write a programme which will add 3 double-byte numbers and stores the result in HL pair (the possible final carry).
   (1) Using ADC instructions. (2) Using DAD instructions. (3) Compare the programmes in the context memory requirements.
   (B) Write a programme to count number of logical '1'in following hexa decimal numbers. And to count the numbers which involve less than 5 logical 1's, C7, B8, A3, 74, 32, 17, D2, E8, 7E, 29, 3C.
   (C) Two double byte decimal nos. are stored consecutively in memory which starts at "X". Write a programme to add these nos. and stores the result in decimal form at the next memory locations. [1] Using register indirect without loop. [2] Using loop i.e. branch control group instruction. [3] Optimise the programme.
6. Experiment Problem-6
   (A) Write a programme for the following type of dis-play. WORD:- ANURADHA [1] Charactor will come from one side slowly in the display field. [2] Stay for longer time and [3] Go away from other side slowly,
   (B) Five single byte nos. are stored at memory starts at X. Write programme
   (i) which will find the largest of these nos. & store it at (X+5) location
   (ii) Which will find the smallest of these nos. & stores it at (X+6) location.
7. Experiment Problem-7
   (A) 4 single byte numbers are stored at "X" consecutively & 4 other single byte numbers are stored at Y. Write a program to exchange these information

between memory blocks X & Y. [1] Using register indirect instruction. [2] Using LHLD, SHLD & XTHL instruction. [3] Compare the programs in the context of memory

(B) Two single byte nos. 0A & 25 are stored at memory location Xand X=1. Write a programme which will obtain the product of these nos. Find total time required for the execution of this program.

(C) Write a programme which will arrange the following numbers in (i) ascending order (ii) descending order. A3, B6, F9 (The numbers are stored at memory starting at 'X'). Finally the arranged numbers must occupy the same memory locations.

8. Experiment Problem-8 Application of 8085 microprocessor.
    (A) Study of DAC Card. Generation of waveforms of definite frequency. (1) Generate the square wave (2) Generate the triangular wave (3) Generate the ramp wave (4) Measure the freq. of each wave by using CRO
    (B) Study of 8255 in mode 0 operation. (1) Construct the display panel for three characters. (2) Write and execute the programme for three digit decimal counter.
    (C) Study of 8255 in mode 0 operation (1) Construct the display panel for 3 characters. (2) Write and execute the programme for free running display of your name.
9. Experiment Problem-9: Application of 8085 microprocessor.
    (A) Study of 8253 timer at mode 0, mode 1 & mode 2 operation.
    (B) STUDY of 8253 timer at mode 3, mode 4 & mode 5 operation.
    (C) 8085 microprocessor based on experiments viz. ADDITION, SUBSTRACTION, MULTIPLICATION, DIVISION, etc. may be performed.

(ii) Condensed Matter Physics-II

It is necessary to perform atleast seven experiments from the list given below.

1. Determination of Lattice parameters using powder photograph /graph.
2. To study lattice dynamics of monoatomic and diatomic molecules.
3. Measurement of Hall coefficient of given semiconductor.
4. Study of Crystal structure by Laue's Pattern.
5. To study variation of ionic conductivity of a given sample with temperature.
6. Determination of Electrical Conductivity of a given material by Four Probe Method.
7. Measurement of photoconductivity of a sample.
8. Study of dislocation motion.
9. Measurement of dislocation density by etch-pit method.
10. Deposition of nano-meter size thin films and determination of its thickness.
11. Determination of Poisson's ratio of glass by Cornu's method.
12. Structural Characterization of Materials (Virtual Lab Experiments http://vlabs.iitkgp.ac.in/scm/#)

(iii) 4PHY-5 (iv) Lab on Photonics-1

A student should perform at least seven experiments from the following list.

1. To set up fiber optic voice communication system.
2. To determine numerical aperture of given optical fiber.
3. Determination of bending loss in multi mode fibers.
4. Magneto optic effect: To determine the angle of rotation as a function of mean flux density using different wavelengths of light and to calculate the corresponding Verdet's constant in each case.
5. Acousto optic effects: Study of density and elasticity in various liquids.
6. To study Pockel's effect.
7. To study Sculpting of plastic optical fiber tip.
8. To fabricate all optical fiber beam splitter.
9. Study of Second Harmonic Generation in crystals.
10. Pulsed laser deposition of thin films. (Demo)
11. Microlithography using High power Nd:YAG laser. **(Demo)**