Anekant Education Society's

TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE AND COMMERCE, BARAMATI

(Autonomous Status)

(Affiliated to Savitribai Phule Pune University, Pune)

Faculty of Science

Department of Physics

Syllabus

For

M.Sc.-II in Physics

From Academic Year 2020-2021

INDEX

PREAMBLE

Physics, a core discipline, is the fundamental and foremost to all natural sciences. It has been significant and influential through advances in its understanding that have translated into new technologies. Physics interact with the society and other discipline such as Medicine, Chemistry, Agriculture, Engineering etc. in many important ways. Physics department in Tuljaram Chaturchand College has highly qualified faculty members and support staffs and is committed towards the development of innovative and handy ways of teaching at graduate, post graduate and developing a core research group for carrying out cutting edge research in various research fields like Condensed Matter Physics, Solid State Physics, Electronics, Theoretical Physics, Atomic & Molecular Physics and Nuclear Physics. The department also offers Doctoral Programme in order to nurture young minds towards embracing various scientific challenges. Extra care is taken to pay individual attention to the students in their laboratory work and tutorial sessions. Project work and problem sessions are encouraged to develop innovative and analytical approach to physics learning.

GOALS

The goal of the Physics education is to provide the student with a broad understanding of the physical principles of the universe, to help them develop critical thinking and quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments. It's provide training for students and planning careers in physics including research, teaching, industrial jobs, government jobs or other sectors of our society.

OBJECTIVES

1. To endow with a conducive and friendly environment that nurtures excellence and high standards of professionalism in teaching, learning and research.
2. To augment the level of participation in research, dissemination and preservation of knowledge for both academic and social development.
3. Prepare the student in assets of Physics and the principles of analytical methods required for the conclusion of physical tests.
4. Provide an opportunity for students to deepen his/her knowledge in the branches of Physics so that views on the outskirts of contemporary science.

5. Training the students on the way of scientific research and enable it to contribute to it under the supervision.
6. Continued development of faculty members by sending them for training courses so as to maintain a high degree of efficiency and performance.
7. Support and encourage the scientific cooperation between faculty members in the department and co-operation with other departments in the field of multi-purpose research.
8. Spread the spirit of competition and encouragement and give the opportunity to all members.
9. Preparation of national cadres by basic physics and knowledge that contribute to community service.
10. To establishes collaborations with other eminent institution.

Proposed Structure of M.Sc. degree in Physics and syllabus for first year degree in Physics as follows:

M.Sc.-II

Semester-III

Course Number	Course Code	Course Name	Credit
11	PHY5301	Statistical Physics	4
12	PHY5302	Solid State Physics	4
13	PHY5303	CB Group –I A) Physics of thin films-I B) Nano-technology-I C) Biomedical Instrumentation-I	4
14	PHY5304	CB Group –II A) Electronic Instrumentation-I B) Laser-I C) Energy Studies-I D) Microcontroller– I	4
15	PHY5305	Special Lab-I	4
16	PHY5306	Project-I	2
Total Credit			**22**

Semester-IV

Course Number		Course Name	Credit
17	PHY5401	Nuclear & Particle Physics	4
18	PHY5402	Material Science	4
19	PHY5403	CB Group –III A) Physics of thin films-II B) Nano-technology-II C) Biomedical Instrumentation-II	4
20	PHY5404	CB Group –IV A) Electronic Instrumentation-II B) Laser-II C) Energy Studies-II D) Microcontroller– II	4
21	PHY5405	Special Lab-II	4
22	PHY5406	Project-II	2
Total Credit			**22**

M. Sc-I (Physics) Semester-II

PHY4201: PHYSICS OF SEMICONDUCTOR DEVICES

Credit: 04 **No. of Lectures: 60**

Learning outcomes:

After completion of the course, the student should be able to:

1. The students should able to utilize semiconductor models to analyze carrier densities and carrier transport.
2. The students should able to understand and utilize the basic governing equations to analyze semiconductor devices.
3. The students should able to understand and analyze the inner working of semiconductor p-n diodes, Schottky barrier diodes and new semiconductor devices.
4. The students should able to explain how the metal-semi conductor contacts will occur.
5. The students should able to explain the working principle of a junction transistor.
6. The students should able to discuss conduction in semiconductors – charge carriers, intrinsic/extrinsic, p-type, n-type.
7. The students should able to Know the physics of semiconductor junctions, metal-semiconductor junctions and metal-insulator-semiconductor junctions.
8. The students should able to apply the knowledge of semiconductors to illustrate the functioning of basic electronic devices.

Unit 1: Properties of Semiconductors (15L)

An introduction to semiconductors, their crystal structure and their band structure, Intrinsic and extrinsic semiconductors, Charge carriers and their effective masses. Carrier concentration at thermal equilibrium for intrinsic and doped semiconductors, Carrier energy distribution, applications of Fermi factor to semiconductors, Density of available states, Excess carriers, carrier transport phenomena, Recombination Process, Basic equation for semiconductor device operation.

Unit 2: PN Junction (15L)

Basic device technology, Depletion region and depletion capacitance, Current Voltage Characteristics: Ideal case, Shockley Equation, Generation recombination process. High injection condition, Diffusion capacitance, Narrow base diode, Junction breakdown.

Unit 3: Junction Transistor & Field Effect Devices (15L)

Formation of transistor, Basic current Voltage relationship, Current gain in transistor, Injection efficiency, base transport factor, Depletion layer and surface recombination, Static characteristics common base and common emitter configurations, Power transistor, General consideration, second breakdown switching transistor, Schottky diode, Semiconductor controlled rectifier, Basic characteristics static characteristics, Dynamic characteristics, Current limiter.

Unit 4: Metal Semiconductor & Metal Insulator Semiconductor Devices (15L)

Schottky effect, Energy Band relation at metal semiconductor contact, Ideal condition and surface states depletion Layer, General expression for barrier height Current, Transport Theory in Schottky barrier, Thermionic Emission Theory, Diffusion theory, Measurement of Schottky barrier height current voltage measurement, Forward characteristics, Reverse characteristics.

Reference Books:

1. Physics of Semiconductor Devices – S.M. Sze
2. Physics Solid State Devices – Streetman B.B.
3. Semiconductor Physics – Smith
4. Fundamentals of Semiconductor Devices – J. Lindmayer and C.Y. Wrigley
5. Physics of Semiconductor Devices – Michael shur
6. Introduction to Semiconductor devices – K.J.M. Rao

M. Sc-I (Physics) Semester-II

PHY4202: ATOMS, MOLECULES & LASER

Credit: 04 **No. of Lectures: 60**

On successful completion of this course student will be able to do the followings.

1. Understand the concept of atomic spectra origin of spectral line, fine and hyperfine structure, Zeeman pashen and stark effect.
2. Describe the coupling scheme metastable state, types of pumping and different applications of laser.
3. Understand the concept of Frank Condon principle, ESR, NMR etc.
4. Understand the concept of different types of laser
5. Demonstrate quantitative problem solving skills in all the topics covered.

Unit 1: Atoms **(15L)**

Introduction, Atomic structure and spectra, quantum states of an electron in an atom, [Exclusion principle and electronic configuration, electron spin, Hund's rule, Maximum multiplicity], Coupling scheme, origin of spectral lines, spectrum of He and alkali atoms, fine and hyperfine structure, isotropic shift, Zeeman and Paschen effect, Stark effect, Selection rule, Problem solving.

Unit 2: Molecules and Resonance Spectroscopy **(15L)**

Introduction, Origin of molecule spectra, Rotational and vibrational spectra for diatomic molecule, vibrational course structure, frank-condon principle, Born–Oppenheimer approximation, electron spectrum and Raman spectrum in diatomic molecule, Electron Spin Resonance (ESR) and Nuclear Magnetic Resonance (NMR) chemical shift , Problem solving.

Unit 3: Lasers. **(15L)**

Introduction, Basic of LASERs (Absorption, spontaneous & Stimulated emission, population inversion), metastable state, Types of Pumping, Gain, Einstein's coefficient, threshold condition, Rate equations for Two level, Three level and Four level laser, rate equation, Problem solving.

Unit 4: Lasers and its applications. (15L)

Introduction, Different types of lasers, He-Ne laser, CO_2 laser, Nd-YAG, Ruby, Excimer laser, Dye laser, semiconductor laser, Applications of Lasers , Industrial applications-Cutting, molding, melting, welding, drilling, Medical applications-Skin therapy, Laser eye surgery, Holography- principle & construction.

Reference Books

1. Molecular structure and spectroscopy, G. Aruldas
2. Fundamentals of molecular spectroscopy, Collin N, Banwell & Elaine M.
3. Atomic and molecular Physics, J. B. Rajam
4. Principles of Laser and their applications, Rhods
5. An introduction to laser theory and application, M. N. Avdhanulu-S. Chand Publication
6. Lasers, A. G. Sigman-Oxfaord University Press 1986.

M. Sc-I (Physics) Semester-II

PHY4203: QUANTUM MECHANICS II

Credit: 04 **Total No. of Lectures: 60**

Learning outcomes:

After completion of the course, the student should be able to:

1. Students should understand the concept of central forces and scattering phenomena
2. Students should learn about partial wave analysis.
3. Students should understand and learn theoretical aspects at Quantum Level.
4. Students should know more about the insight of the microscopic world.
5. Students should understand the behaviour of particles under Classical and Quantum conditions.

Revision and general formalism:

Time-independent Perturbation theory: Non degenerate, degenerate, Introduction to Time-dependent Perturbation theory.

Unit 1: Approximation Methods II **(15 L)**

Introduction, Time dependent Perturbation theory: Transition amplitude, 1^{st} and 2^{nd} order, selection rules, Fermi's golden rule, Harmonic perturbation, dipole approximation, Einstein coefficient for spontaneous emission.

Variational method: Basic principles and application to hydrogen atom, helium atom, deuteron problem, Vander walls interaction.

WKB approximation: General formalism, Bound states for potential wells – with no rigid walls, with one rigid wall, with two rigid walls. Bohr's quantization condition, Application to tunneling, field emission

Unit 2: Theory of Scattering **(15 L)**

Introduction, Collisions in 3-D and scattering: Laboratory and CM reference frames; scattering amplitude, differential scattering cross section and total scattering cross section: scattering by spherically symmetric potentials, Method of partial waves, Phase shift, Ramsauer-Townsend effect, scattering by a perfectly rigid sphere and by square well potential, Yukawa potential. The Born approximation, Lippman-Schwinger equation, applications and validity of the Born approximation.

Unit 3: Symmetries in quantum mechanics and Identical Particles (15 L)

Conservation laws and degeneracy associated with symmetries; Continuous symmetries, space and time translations, rotations; Rotation group, homomorphism between SO (3) and SU (2); Explicit matrix representation of generators for $j = \frac{1}{2}$ and j = 1; Rotation matrices; Irreducible spherical tensor operators, Wigner-Eckart theorem; Discrete symmetries, parity and time reversal.

Identical Particles:

Meaning of identity and consequences, Symmetric and antisymmetric wave functions, Slater determinant, Symmetric and antisymmetric spin wave functions of two identical particles, Collisions of identical particles, Pauli's exclusion principle and Slater determent.

Unit 4: Relativistic Quantum Mechanics (15 L)

Klein-Gordon equation, Feynman-Stuckelberg interpretation of negative energy states and concept of antiparticles, Dirac equation, covariant form, adjoint equation, Plane wave solution and momentum space spinors, Spin and magnetic moment of the electron, Non relativistic reduction, Helicity and chirality, Properties of γ matrices, Charge conjugation, Normalisation and completeness of spinors.

What NEXT with Quantum Mechanics? : Anti communication numbers, Quantisation of electromagnetic field, 'reverse time' using algorithm on a computer, past and future.

Reference Books:

1. Quantum Mechanics by Nouredine Zettili, A John Wiley and Sons, Ltd.
2. Modern Quantum Mechanics by J. J. Sakurai.
3. A Text-book of Quantum Mechanics by P. M. Mathews and K. Venkatesan.
4. Quantum mechanics by A. Ghatak and S. Lokanathan.
5. Quantum Mechanics by L. I. Schiff.
6. Quantum Physics by R. Eisberg and R. Resnick.
7. Introduction to Quantum Mechanics by by David J. Griffiths.

8. Introductory Quantum mechanics by Granier, Springer Publication.
9. Introductory Quantum Mechanics by Li boff, 4th Edition, Pearson Education Ltd.
10. Principles of Quantum Mechanics by Shankar R. IInd Edition (Plenum, 1994).

M. Sc-I (Physics) Semester-II

PHY4204: ELECTRODYNAMICS

Credit: 04 **No. of Lectures: 60**

Learning Outcomes:

On successful completion of this course students will be able to do the following

1. Understand the concept of multipole expansions and deeper meaning of Maxwell's equations
2. Understand the technique of deriving formulae for the electromagnetic waves in stationary and conducting medium
3. Calculate the electromagnetic radiations from moving charges ,taking into account retardation effects and make a detailed account for Gauge transformations
4. Embracing the concepts of special relativity as emerged through the laws of electrodynamics
5. To formulate and solve the electromagnetic problems skills In all the topics covered

Unit 1: Multiple Expansions and Time Varying Fields (15 L)

Multiple expansions for a localized charge distribution in free space, linear quadrapole potential and field, static electric and magnetic fields in material media, boundary conditions, Time dependent fields, Faraday's law for stationary and moving media, Maxwell's displacement current, differential and integral forms of Maxwell's equations, Maxwell's equations for moving medium.

Unit 2: Energy, Force, Momentum Relations and Electromagnetic Wave Equations (20 L)

Energy relations in quasi-stationary current systems, Magnetic interaction between two current loops, Energy stored in electric and magnetic fields, Poynting's theorem, General expression for electromagnetic energy, Electromagnetic wave equations, Electromagnetic plane waves in stationary medium, Reflection and refraction of electromagnetic waves at plane boundaries (Oblique incidence), Electromagnetic waves in conducting medium, Skin effect and skin depth, wave guides , Dispersion relations(solid, liquid, gas)

Unit 3: Inhomogeneous Wave Equations (15 L)

Inhomogeneous wave equations, Lorentz's and Coulomb's gauges, Gauge transformations, Wave equations in terms of electromagnetic potentials, D'Alembertian operator, Hertz potential and its use in computation of radiation fields. Radiation from moving charges, radiation from a dipole.

Unit 4: Relativistic Mechanics and Covariance (10 L)

Galilean Transformation, Lorentz transformations, Relativistic velocity addition, Minkowski's space-time diagram, Four vector potential, electromagnetic field tensor, Lorentz force on a charged particle.

References:

1) Introduction to Electrodynamics, (3rd Edition) by David J. Griffith Publication: Prentice-Hall of India, New Delhi.
2) Introduction to Electrodynamics, by A.Z. Capri and P.V. Panat Narosa Publishing House.
3) Foundations of Electromagnetic theory by Reitz & Milford, World student series Edition.
4) Classical Electrodynamics, by J.D. Jackson, 3rd Edition John Wiley.
5) Electromagnetic theory and Electrodynamics by Satya Prakash, Kedar Nath and Co- Meerut.
6) Electromagnetics by B.B. Laud, Willey Eastern.
7) Matrices and Tensors in Physics by A. W. Joshi, 3rd Edition, New Age International.
8) Electrodynamics by Kumar Gupta and Singh.
9) Electromagnetic Theory by Umesh Sinha, Satya prakashan tech. India Publication.

M. Sc-I (Physics) Semester-II

PHY4205: ELECTRONICS LABORATORY-II

Credits: 04

(Students have to perform Any 10 Experiments)

Learning Outcomes:

After successfully completing this laboratory course the students will be able to do the following

1. Acquire technical and manipulative skills by using laboratory equipment, tools and materials
2. Demonstrate a deeper understanding of abstract concept and theories gained by experiencing and visualizing them as authentic phenomena.
3. Understanding the basic design of circuit which related to experiment.
4. Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

1. Precision rectifier.
2. Frequency to voltage converter using OP-AMP.
3. Sample and hold circuits.
4. Shift Register using 7495.
5. Class-B push pull amplifier using Dual power supply and OP-AMP.
6. Fold back power supply.
7. Design, built and test oscillator-phase shift oscillator.
8. Study of voltage controlled oscillator using IC-566.
9. Frequency multiplier using PLL-565.
10. CVCC using OP-AMP.
11. Study of multiplexer and Demultiplexer.
12. Frequency modulation and demodulation.
13. Pulse code modulation and demodulation.
14. FSK modulation and demodulation.
15. 8-bit ADC.
16. Design, built and test oscillator – LC oscillator

M. Sc-I (Physics) Semester-II

PHY4206: BASIC PHYSICS LABORATORY-II

Credits: 04

(Students have to perform Any 10 Experiments)

Learning Outcomes:

After completion of the course, the student should be able to:

1. Acquire technical and manipulative skills by using laboratory equipment, tools and materials

2. Demonstrate a deeper understanding of abstract concept and theories gained by experiencing and visualizing them as authentic phenomena.

3. Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

1. Skin depth in Al using electromagnetic radiation.
2. Franck – Hertz Experiment.
3. Thermionic Emission.
4. Electron Spin Resonance (ESR).
5. Study of Hysteresis (B-H curve)
6. Ionic Conductivity of NaCl.
7. Zeeman Effect.
8. Study of electromagnetic damping
9. Study of the characteristics of a laser beam (Beam Divergence).
10. Determination of wavelength of He-Ne LASER by Reflection grating
11. Energy gap of semiconductor.
12. e/m by Thomson's method
13. Measurement of the focal length of a given convex lens using a laser.
14. Determination of wavelength of He-Ne LASER by transmission grating
15. Determination of Polarisation
16. G.M. counter: Determination of dead time of GM tube by Double source method

M.Sc.-II

Semester-III

Course Number	Course Code	Course Name	Credit
11	PHY5301	Statistical Physics	4
12	PHY5302	Solid State Physics	4
13	PHY5303	CB Group –I 1) Physics of thin films-I 2) Nano-technology-I 3) Biomedical Instrumentation-I	4
14	PHY5304	CB Group –II 1) Electronic Instrumentation-I 2) Laser-I 3) Energy Studies-I 4) Microcontroller– I	4
15	PHY5305	Special Lab-I	4
16	PHY5306	Project-I	2
Total Credit			**22**

Semester-IV

Course Number		Course Name	Credit
17	PHY5401	Nuclear & Particle Physics	4
18	PHY5402	Material Science	4
19	PHY5403	CB Group –III 1) Physics of thin films-II 2) Nano-technology-II 3) Biomedical Instrumentation-II	4
20	PHY5404	CB Group –IV 1) Electronic Instrumentation-II 2) Laser-II 3) Energy Studies-II 4) Microcontroller– II	4
21	PHY5405	Special Lab-II	4
22	PHY5406	Project-II	2
Total Credit			**22**

M. Sc-II (Physics) Semester-III

PHY 5301: STATISTICAL PHYSICS

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

On successful completion of this course students will be able to do the following

1. Understand the relevant quantities used to describe macroscopic systems ,thermodynamic potentials and ensembles
2. Understand the concepts of partition functions by taking into account the different types of ensemble
3. Describe the consequences in classical and quantum statistics
4. Embracing the concepts of ideal Bose and fermi systems through the principle of statistical Mechanics
5. Show an analytic ability to solve the statistical mechanics problems

Unit1: Statistical Description and Thermodynamics of Particles (15L)

Revision of laws of thermodynamics, statistical ensemble, postulates of equal a priori probability, behavior of density of states, Liouville's theorem(classical), Equilibrium conditions and constraints, Distribution of energy between systems in equilibrium, Approach to thermal equilibrium, Sharpness of the probability distribution, Dependence of the density of states on the external parameters, Equilibrium between interacting systems, Thermodynamical laws and basic statistical relations (Revision)

Unit 2: Classical Statistical Mechanics: (15L)

Micro-canonical ensemble, System in contact with heat reservoir, Canonical ensemble, Applications of canonical ensembles (Paramagnetism, Molecule in an ideal gas, Law of atmosphere), System with specified mean energy, Calculation of mean values and fluctuations in a canonical ensemble, Connection with thermodynamics, Grand-canonical ensemble, , Chemical potential in the equilibrium state, Mean values and fluctuations in grand canonical ensemble, Thermodynamic functions in terms of the Grand partition function

Unit 3: Applications of Statistical Mechanics and Quantum Distribution (15L)

Calculations of thermodynamic quantities, Ideal monoatomic gas, Gibbs paradox, Equipartition theorem and its Simple applications. i) Mean kinetic energy of a molecule in a gas ii) Brownian motion iii) Harmonic Oscillator iv) Specific heat of solid, Maxwell velocity distribution, Related distributions and mean values Symmetry of wave functions, Quantum distribution functions, Boltzmann limit of Boson and Fermions gases, Maxwell Boltzman statistics, B-E statistics, F-D statistics, Evaluation of the partition function, Partition function for diatomic molecules, Equation of state for an ideal gas, quantum mechanical paramagnetic susceptibility

Unit 4: Ideal Bose and Fermi Systems: (15L)

Photon gas – i) Radiation pressure ii) Radiation density iii) Emissivity iv) Equilibrium number of photons in the cavity, Einstein derivation of Planck's law, Bose Einstein Condensation, Specific heat, Photon gas – Einstein and Debye's model of solids Fermi energy, Mean energy of fermions at absolute zero, Fermi energy as a function of temperature, Electronic specific heat, White – Dwarfs (without derivation), comparison of M-B statistics, F-D statistics, and B-E statistics, comparison between classical statistics and quantum statistics.

Reference books:

1. Fundamentals of Statistical and Thermal Physics, - F. Reif,
2. Fundamentals of Statistical Mechanics, B.B. Laud, New Age International Publication
3. Statistical Mechanics, R.K. Pathria, Bufferworgh Heinemann (2nd Edition)
4. Statistical Mechanics, K. Huang, John Willey and Sons (2nd Edition)
5. Statistical Mechanics, Satya Prakash and Kedar Nath Ram, Nath Publication (2008)
6. Statistical Mechanics by Loknathan and Gambhir

M. Sc-II (Physics) Semester-III

PHY 5302: SOLID STATE PHYSICS

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

On successful completion of this course students will be able to do the following

1. The course aims through a theoretical and experimental approach to give fundamental insights into solid state physics.
2. The students should be able to do quantitative calculations based on established theoretical models to describe the properties of materials.
3. The Students should Knows Effective mass and E-k relationship
4. Students will gain knowledge of basic theories of the magnetic properties of materials.
5. Students will be able to analyze electron transport and energy related problems by applying quantum mechanical principles
6. Students will be able to analyze the lattice vibration phenomenon in the solids

Unit 1: Band Theory of Solids **(15L)**

Introduction, Nearly free electron model, DC and AC electrical conductivity of metals, Bloch theorem (with proof), Kronig-Penney model, Motion of electron in 1-D according to band theory, Distinction between metals, insulators and intrinsic semiconductors, Reduced, periodic & extended zone schemes, Cyclotron resonance, Quantization of electronic orbit in a magnetic field.

The electrical conductivity at low temperature, The thermal conductivity of metals, Dielectric Properties of insulators. Macroscopic electrostatic Maxwell equations, Theory of Local Field, Theory of polarizability, Clausius- Mossotti relation, Long- wavelength optical modes in Ionic crystals.

Unit 2: Diamagnetism and Paramagnetism **(15L)**

Introduction, Classical theory of diamagnetism, Langevin theory of Paramagnetism, Quantum theory of Paramagnetism, Paramagnetic susceptibility of conduction electron, Magnetic properties of rare earth ions & iron group ions with graphical representation, Crystal field splitting, Quenching of orbital angular momentum.

Unit 3: Ferromagnetism, Antiferromagnetism and Ferrimagnetism (15L)

Introduction, Ferromagnetism: Wiess theory, Curie point, Exchange integral, saturation magnetization and its temperature dependence, Saturation magnetization at absolute zero, ferromagnetic domains, Anisotropy energy, Bloch wall, Quantum theory of ferromagnetism Magnetic resonance, Nuclear magnetic resonance (NMR), The resonance condition, Antiferromagnetism: Neel temperature, Ferrimagnetism: Curie temperature, susceptibility of ferrimagnets.

Unit 4: Carbon based materials (15L)

Allotropes of carbon: Diamond, Graphite, Graphene, Amorphous carbon, Glassy carbon

Carbon nanostructure: Fullerenes, Carbon Nanotube (CNTs), Carbon Nanofiber (CNFs), Graphene

Synthesis methods of graphene oxide: Original Hummers method, modified Hummers method

Graphene oxide reduction: Thermal reduction mechanism, Thermal reduction in various atmospheres

Graphene: Applications

Reference Books:

1. Introduction to solid states Physics - Charles, Kittle 7th Edition
2. Introductory Solid States Physics – H. P. Myers
3. Solid States Physics - S.O. Pillai (latest edition)
4. Elementary Solid States Physics- M. Ali Omar
5. Problem in Solid State Physics – S.O. Pillai
6. Solid States Physics – A. J. Dekkar
7. Solid states Physics – Wahab
8. Solid State Physics: Neil W. Ashcroft, N. David Mermin
9. Solid States Physics – Ibach & Luth
10. Solid States Physics – C. M. Kacchawa
11. Wet Chemical Synthesis of Graphene for Battery Applications - Ida Johansen

M. Sc-II (Physics) Semester-III

CB Group –I: 1. PHY 5303: PHYSICS OF THIN FILM-I

Credit: 04 **Total No. of Lectures: 60**

Leaning Outcomes:

After completion of the course, the student should be able to:

1. Discuss the differences and similarities between different vacuum-based deposition techniques,
2. Evaluate and use of different models for nucleation and growth of thin films
3. Asses the relation between deposition technique, film structure and film properties
4. Discuss typical thin film applications such as solar cell, photo catalysis, gas sensors, super capacitor etc
5. Motivate selection of deposition techniques for various applications.
6. Comprehend the materials presented in the lecture and to draw conclusions from them, as well as to actively communicate the contents presented during the lecture.

Unit 1: Introduction to thin films **(15L)**

Overview of vacuum techniques, Comparison of thin and thick films, Theory of growth of thin films: Nucleation, condensation, Frank-Van der Merwe model, Volmer-Weber model, Stranski-Krastanov model, Capillarity model, Atomistic model, comparison of models, various stages of film growth.

Unit 2: Deposition Techniques and Measurement of thickness **(15L)**

Physical methods: Vacuum Techniques (i) Thermal evaporation methods: Resistive heating, Electron Beam Evaporation, (ii) Sputtering system: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering. Chemical Methods: Chemical vapor deposition system (CVD), Chemical bath deposition: Ionic and solubility products, Preparation of binary semiconductors, Electrochemical deposition: Deposition mechanism and Preparation of compound thin films, Spray pyrolysis: Deposition mechanism and preparation of compound thin films. Doctor blade technique, Dip coating and Spin coating, Photolithography, Electron–beam deposition, Pulsed Laser Ablation, Tolansky technique, Talystep (styles) method, Quartz crystal microbalance, Stress measurement by optical method, Gravimetric method.

Unit 3: Properties of thin films **(15L)**

Electrical Properties: Source of Resistivity in Metallic conductors, Influence of thickness on the resistivity of thin films, Hall Effect & Magnetoresistance in thin films, Fuch-Sondhemir theory, TCR and its effects. Mechanical properties: Adhesion & its measurement with mechanical and nucleation methods, stress measurement by using optical method. Optical properties: Absorption and transmission.

Unit 4: Applications of Thin Films **(15L)**

Resistors, capacitors, Junction devices (Metal semiconductor junction) Solar cells, ICs, Optical coating, Thin film sensors (gas and humidity), Thin films for information storage, electro acoustics and telecommunication.

Reference books:

1. Hand book of Thin Film Technology: Maissel and Glang, (Mc Graw Hill)
2. Thin Film Phenomena: K. L. Chopra, (Mc Graw Hill)
3. Material Science of Thin Films: M. Ohring, (Academic Press)
4. Thin Film Process: J. L. Vossen and Kern, (Academic Press)
5. Vacuum Technology (2 nd revised edition), A. Roth, (North Hollad)

M. Sc-II (Physics) Semester-III

CB Group –I: 2. PHY 5303: NANO TECHNOLOGY-I

Credit: 04 **Total No. of Lectures: 60**

Learning outcomes:

After completion of the course, the student should be able to:

1. Students will be able to learn about the background on Nanoscience
2. Students will be able to understand the synthesis of nano materials and their application and the impact of nano materials on environment
3. Students will be able to apply their learned knowledge to develop Nanomaterial's.
4. Students will be able to apply principles of basic science concepts in understanding, analysis and prediction of matter at Nano scale.
5. Students will be able to introduce advanced ideas and techniques required in emergent area of nano technology.
6. Students will be able to understand and apply mathematical techniques for describing and deeper understanding of nano systems.

Unit 1: Science at Nano scale **(15L)**

Nano and Nature: Nanoscopic colours (Butterfly wings), Bioluminescence (fireflies), Tribology (Gecko's Sticky Feet, Nasturtium Leaf-Lotus effect etc) in nature.

Classification of nano materials:

0D, 1D, 2D and 3D and types of nano materials (QDs, QW, CNT's, Bucky Balls, Nano composites etc)

Nano science:

Quantum mechanics, Brownian motion, surface forces, surface to volume ratio

Making of nanostructures:

Top down Overview of top down nano fabrication processes. Mechanical grinding (ball milling)

Making of nano structures:

Bottom up, overview of bottom up nanofabrication processes Solid state phase synthesis

Unit 2: Physical Properties of Nano materials **(15L)**

Surface Properties:

Surface energy – chemical potential as a function of surface curvature-Electrostatic stabilization- surface charge density-electric potential at the proximity of solid surface-Van der Waals attraction potential

Mechanical properties

Melting point and lattice constants, Electrical conductivity (Surface scattering, Change of electronic structure, quantum transport).

Magnetic properties of Nano materials

Origin of magnetism in materials, Classification into Dia-, Para- and Ferro-magnetic materials, Hysteresis in ferromagnetic materials, domains, soft and hard magnetic materials, Coercivity vs particle size

Unit 3: Nano structured materials **(15L)**

Nano ceramics:

Dielectrics, ferroelectrics and magneto ceramics, Magnetic properties

Nano polymers:

Preparation and characterization of di block Copolymer based Nano composites, Nanoparticles polymer ensembles; Applications of Nano polymers

Nano composites:

Metal-Metal nano composites, Polymer-Metal nano composites, Ceramic nano composites

Special Nano materials:

Graphene, Carbon nano tubes and Types (CNT), Fullerenes, Aerogels, Core Shell Nanostructures

Unit 4: Synthesis techniques of Nano materials **(15L)**

Physical methods:

Vacuum Techniques (i) Thermal evaporation methods: Resistive heating, Electron Beam Evaporation, (ii) Sputtering system: Glow discharge, DC sputtering, Radio frequency sputtering, Magnetron sputtering, Ion beam sputtering.

Chemical Methods:

Chemical bath deposition: Ionic and solubility products, Preparation of binary semiconductors, Electrochemical deposition: Deposition mechanism and Preparation of compound thin films, Spray pyrolysis: Deposition mechanism and preparation of compound thin films.

Reference books:

1 Nanotechnology principle and practices by Sulabha K. Kulkarni (2007).

2 Klabunde, K.J. (Ed.), "Nanoscale Materials in Chemistry", John Wiley & Sons Inc. 2001

3 Nalwa, H.S. (Ed.), "Encyclopedia of Nanoscience and Nanotechnology" 2004

4 Sergeev, G.B. Nanochemistry, Elsevier, B.V. 2010

5 Schmid, G. (Ed.), "Nanoparticles", Wiley-VCH Verlag GmbH & Co. KgaA.2004

6 Rao, C.N.R., Müller, A. and Cheentham, A.K. (Eds.),"Chemistry of Nanomaterials", Wiley – VCH. 2005

7 Carbon Nanotubes: Properties and Applications- Michael J. O'Connell.

8 Carbon Nanotechnology- Liming Dai.

9 Nanotubes and Nanowires- CNR Rao and A Govindaraj RCS Publishing.

M. Sc-II (Physics) Semester-III

CB Group –I: 3. PHY 5303: BIOMEDICAL INSTRUMENTATION-I

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

After completion of the course, the student should be able to:

1. Explain the different medical imaging systems, compare advantages and disadvantages, understand the limitations and find the best suitable method for different pathological diagnoses.
2. Explain and describe different diagnostic measurement methods for identification of human biopotentials and their necessary instrumentation.

Unit 1: Fundamentals to Biomedical Instrumentation and patient safety (15L)

1.1 Basic medical instrumentation system.

1.2 System configuration

1.3 basic characteristics of measuring system

1.4 Problems faced when measuring a human body

1.5 Essentials of biomedical instrumentation.

1.6 Electric shock hazards-Gross shock-Micro current shock

1.7 Precautions to minimize electric shock hazards

Unit 2: Electrodes and physiological transducers: (15L)

3.1 Electrode Theory

3.2 Biopotential Electrodes

3.3 Electrodes for ECG, EEG, EMG.

3.4 Introduction to physiological transducers

3.5 Classification of Transducer

3.6 Performance characteristic of transducer.

3.7 Displacement, position and motion transducer.

3.8 Pressure transducer

3.9 Transducer for Body temperature measurement

3.10 Biosensors

Unit 3: Recording Systems and Signal Analysis: **(15L)**

3.1 Basic recording system.

3.2 General consideration for signal conditioners

3.3 Preamplifiers, Differential, Instrumentation, Isolation amplifier.

3.4 Source of noise in low level measurement.

3.5 Biomedical signal analysis techniques

3.6 Fourier Transform, FFT and Wavelet Transform

3.7 Signal processing techniques.

Unit 4: Cardiovascular System and Measurements: **(15L)**

4.1 The Heart.

4.2 The Heart and Cardiovascular system

4.3 Blood Pressure

4.4 Heart Sounds.

4.5 Block diagram of electrocardiograph

4.6 The ECG leads

4.7 Effect of Artifacts on ECG recording

4.8Introduction to pacemakers

4.9 Types of pacemakers

4.10 Need for pacemakers

4.11Pacemaker system and its functioning

Reference Books:

1. Biomedical Instrumentation and Measurements (Second edition)
   By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) by R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

M. Sc-II (Physics) Semester-III

CB Group –II: 1. PHY 5304: ELECTRONIC INSTRUMENTATION-I

Credit: 04 **Total No. of Lectures: 60**

After successful completion of this course the students will be able to-

1.Understand the principles and functions of different instruments.

2.Use different instruments for measurement of various parameters.

3.Design experiments using sensors.

Unit 1: General Background and Measurements **(15L)**

1.1 General configuration and functional description of measuring instruments with examples of instruments and their functional description. (Ref.1: #2.1 to 2.4).

1.2 Input output configuration of measuring instruments, and methods of correction of unwanted inputs.(Ref.1: #2.5)

1.3 1.2 Qualities of measurements (Ref.9 Ch# 1)

I] Static characteristics II] Dynamic characteristics: Generalized mathematical model of measurement System, III] Order of instruments: zero, first and second order. (Ref.1: #3.3 94 to 115 & 123 to131)

1.4 Errors in measurement, Types of errors, sources of errors (Ref.9)

References: 1, 3, 9

Unit 2: Transducers **(15L)**

2.1 Displacement Measurement: a) Resistive Transducers (variable resistance, Strain gauges, Electrical strain gauges), b) Inductive transducers (LVDT, variable reluctance), c) Capacitive transducers

2.2 Pressure Measurement: a) Non-Elastic pressure transducers (Barometer, Manometer)

b) Elastic pressure transducers (Diaphragm, Bellows, Bourdon gauge), c) Electrical pressure transducers (Piezoelectric transducer)

2.3 Temperature Measurement: a) Electrical Method (RTD, Platinum resistance thermometer, Thermistor), b) Thermocouple EMF measuring Circuit, c) Non-contact Type (Semiconductor temperature sensors, Radiation pyrometers

References: 9

Unit 3: Signal Conditioners, Data acquisition and conversion **(15L)**

3.1 Signal conditioners: Op-amps, instrument amplifier, bridge, phase sensitive detector

3.2 Data Acquisition System (DAS): DAS, hardware, Single channel DAS, Multi channel DAS

3.3 Data Converters: D to A and A to D converters, Data loggers,

References: 9

Unit 4: Indicators, Display system and Oscilloscope **(15L)**

4.1 Digital display system and Indicators

4.2 Classification of Displays

4.3 Light Emitting Diodes (LED)

4.4 Liquid Crystal Display (LCD).

4.5 Printers: principle of Laser printers

4.6 Cathode Ray Oscilloscope (CRO)

4.7 Cathode Ray Tube (CRT)

4.8 Digital Storage Oscilloscope (DSO)

References: 9

Reference Books:

1. Measurement systems- applications and design. 4th edn E.O. Doeblin.
2. Measurement system – applications and design by E.O. Doblin and Manik .
3. Instrumentation, measurement and systems. Nakra and Chaudhary.
4. Electronic Instrumentation and measurement techniques by A. D. Helfrick and W. D. Cooper. (Pearson.)
5. Instrumentation, devices and systems. Rangan, Mani and Sarma Prentice Hall of India. 18 6. Process controlled instrumentation by C. D. Johnson.
7. Elements of Electronic Instrumentation and measurement. 3rd edn. Joseph Carr. (Pearson).
8. Sensors and transducers. Patranabis.
9. Electronics Instrumentation. Kalsi (Tata McGraw-Hill)

M. Sc-II (Physics) Semester-III

CB Group –II: 2. PHY 5304: LASER-I

Credit: 04 **Total No. of Lectures: 60**

After successful completion of this course the students will be able to-

1. Describe the requirements for a system to act as a laser.
2. Differentiate the various types of lasers and their means of excitation.
3. Relate the structure and properties of lasers to their performance and intended applications.

Unit 1: Basic of Lasers (15L)

Introduction, Historical background of laser, Einstein coefficients and stimulated light amplification, population inversion, Creation of population inversion in three level & four level lasers, Problem Solving.

Unit 2: Types of Lasers Systems (15L)

Introduction, Gas Laser: (CO2 laser), Solid State Laser, Host material and its characteristics, doped ions: (Nd: YAG laser), Liquid laser: (Dye laser), Semiconductor laser.

Unit 3: Laser Beam Propagation (15L)

Introduction, Laser beam propagation, properties of Gaussian beam, resonator, stability, various types of resonators, resonator for high gain and high energy lasers, Gaussian beam focusing.

Unit 4: Detection and some applications of laser (15L)

Detection of optical radiation: Human eye, thermal detector (bolometer, pyro-electric), photon detector (photoconductive detector, photo voltaic detector and photoemissive detector), p-i-n photodiode, APD photodiode

Holography: Importance of coherence, Principle of holography and characteristics, Recording and reconstruction, classification of hologram and application, non-destructive testing, injection laser diode (double heterostructure , distributed feedback)

Reference Book:

1. Principles of lasers- O Svelto
2. Solid State Laser Engineering- W Koechner
3. Laser- B A Labgyel
4. Gas laser- A J Boom
5. Methods of Experimental Physics Vol. 15B ed. By C L Tang
6. Industrial Application of Lasers – J F Ready
7. Handbook of Nonlinear Optics- R L Sautherland
8. Laser and electro optics- C C Davis
9. Fibre optic communication- Joseph C Palais
10. Fundamentals of light sources and lasers – Mark csele

M. Sc-II (Physics) Semester-III

CB Group –II: 3. PHY 5304: ENERGY STUDIES-I

Credit: 04 **Total No. of Lectures: 60**

Learning outcomes:

After completion of the course, the student should be able to:

1. Define basic properties of different renewable sources of energy and technologies for their utilisation
2. Describe main elements of technical systems designed for utilisation of renewable sources of energy,
3. Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications

Unit 1: Energy and Thermodynamics (15L)

Different forms of Energy, Conservation of Energy, Entropy, Enthalpy, Heat capacity, Specific heat capacity, Thermodynamic cycles: Brayton, Carnot Diesel, Otto and Rankin cycle; Fossil fuels, time scale of fossil fuels and solar energy as an option.

Unit 2: Solar Energy for Clean Environment (15L)

Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment, Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy, Hybrid wind energy systems - wind + diesel power, wind + conventional grid, wind +Photovoltaic system etc.

Unit 3: Wind Energy (15L)

Origin and classification of winds, Aerodynamics of windmill: Maximum power, and Forces on the Blades and thrust on turbines; Wind data collection and field estimation of wind energy, Site selection, Basic components of wind mill, Types of wind mill, Wind energy farm, Hybrid wind energy systems: wind + PV; The present Indian Scenario. Concept of wind form & project cycle, Cost economics & viability of wind farm

Unit 4: Biomass Energy and Biogas Technology (15L)

Importance of biogas technology, Different Types of Biogas Plants, Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas (cow dung, human and other agricultural waste, municipal waste etc.) Individual and community biogas operated engines and their use. Removal of CO_2 and H_2O, Application of Biogas in domestic, industry and vehicles, Bio-hydrogen production, Isolation of methane from Biogas and packing and its utilization

Reference Books

1. Biomass, Energy and Environment- N.H. Ravindranath and D.O Hall, Oxford University Press.
2. Solar Energy and Rural development- S.H. Pawar, C.D. Lokhande and R.N. Patil.
3. Biomass Energy- S.H. Pawar, L.J. Bhosale, A.B. Sabale and S.K. Goel.
4. Solid State Energy Conversion-S.H. Pawar, C.H. Bhosale, and R.N. Patil
5. Solar Energy Conversion-A.E. Dixon and J.D. Leslie.
6. Advances in Energy systems and technology- Peter Auer.

M. Sc-II (Physics) Semester-III

CB Group –II: 4. PHY 5304: MICROCONTROLLER– I

Credit: 04 **Total No. of Lectures: 60**

After successful completion of this course the students will be able to-

1. Explain the planning of memory of microcomputer system.
2. Examine the construction of CPU, know registers and bus systems.
3. Compare microprocessors and microcontroller. Know the structural differences between microprocessors and microcontrollers

Unit 1: ARCHITECTURE OF 8051 **[10L]**

Comparison of Microprocessor and Microcontroller, Overview of the 8051 family, Block diagram of Microcontroller, Functions of each block, Pin details of 8051, A and B CPU registers, Flags and Program status word (PSW), Program Counter and Data Pointer, PSW register, Memory Organization of 8051, Internal RAM, Stack and Stack Pointer, Special function registers, Internal ROM, I/O Ports, Oscillator and Clock

Unit 2: 8051 ASSEMBLY LANGUAGE PROGRAMMING **[10L]**

Introduction to 8051 Assembly programming, Assembling and running an 8051 program, 8051 data types and directives, Intel hex file, Jump, loop, and call instructions, 8051 I/O Programming, Addressing modes

Unit 3: ARITHMETIC & LOGIC INSTRUCTIONS AND PROGRAMS **[10L]**

Arithmetic instructions, Signed number concepts and arithmetic operations, Logic And Compare instructions, Rotate instruction, BCD, ASCII, and other application programs.

Unit 4: TIMER AND INTERRUPTS PROGRAMMING IN ASSEMBLY/C: **[10L]**

Timers. Programming 8051 timers, counter programming, Programming timers 0 and 1 in 8051, 8051 interrupts, Interrupt priority in the 8051

Unit 5: SERIAL COMMUNICATION: **[10L]**

Basics of Serial programming, RS 232 Standards, 8051 connection to RS 232, 8051 Serial Communication Programming,

Unit 6: INTERFACING TECHNIQUES **[10L]**

LCD and Keyboard interfacing, ADC, DAC, and sensor interfacing (LM35)

Reference Books:

1. 8051 Microcontroller by Kenneth J.Ayala.
2. 8051 Microcontroller and Embedded Systems using Assembly and C by Mazidi, Mazidi and D MacKinlay, 2006 Pearson Education Low Price Edition.
3. Microprocessor and Microcontroller by R.Theagarajan, Sci Tech Publication, Chennai
4. Programming customizing the 8051 Microcontroller by MykePredko, Tata McGraw Hill

M. Sc-II (Physics) Semester-IV

PHY 5401: NUCLEAR AND PARTICLE PHYSICS

Credit: 04 **Total No. of Lectures: 60**

On successful completion of this course students will be able to do the following

1. Understand the basic concepts of general properties of nuclei
2. Usage of basic laws in determination of particle properties and properties of processes in the subatomic world.
3. Describe the particle interactions with matter and basic models of the atomic nucleus
4. Embracing the concepts of the radiation detectors and accelerators
5. Describe the Nuclear Physics applications

Unit 1: General Properties and concepts of Nuclei (15L)

General Properties of nuclei :Charge, Nuclear mass, Nuclear binding energy, Mass defect, Nuclear radius, Angular momentum, Nuclear spin ,Parity, Magnetic dipole moments &Electric quadrupole moments of nuclei, Radioactivity and Unit of radiation, Different types of decays: Alpha Decay: Velocity of Alpha Particles, Disintegration Energy, Range-Energy Relationship, Geiger-Nuttal Law, Beta Decay: Conditions for Spontaneous Emission of β^-& β^+ Particles, Selection Rules, Origin of Beta Spectrum-Neutrino Hypothesis, Gamma Decay: Decay Scheme of ^{137}Cs &^{60}Co Nuclei, Internal Conversion, Internal Pair Creation.

Unit 2: Radiation Detectors and Nuclear Models (15L)

Detectors: NaI(Tl) Scintillation Detector, Si(Li) and Ge(Li) Detectors, High Purity Germanium Detector, Bubble Chamber, Cloud Chamber, Spark Chamber, Nuclear Models: Liquid drop model and empirical mass formula ,Shell Model with details of magic numbers, Predictions of the Shell Model, Achievements & Failures of shell Model, Fermi Gas Model, Collective Model.

Unit 3: Reaction Dynamics, Nuclear Reactors and Accelerators (15L)

Reaction Dynamics: Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions, Q-value and threshold energy of nuclear reactions, Compound Nucleus Hypothesis, Reactors: Fission Chain Reaction, Four Factor Formula, Multiplication Factor, General Properties and Concepts of Nuclear Reactors, Reactor Materials, Types of Reactors, List of Different Types of Reactors Developed in India, Accelerators: Van de Graff, Microtron, Electron & Proton Synchrotron, Pelletron, Cyclotron.

Unit 4: Elementary Particle Physics (15L)

Classification of Elementary Particles and their Quantum Numbers(Charge, Spin, Parity,Iso-Spin, Strangeness, Baryon number, Hypercharge etc.), conservation laws ,Classification of Quarks, Their masses and spins, Quark contents of particles ,CPT invariances, Parity non conservation in weak interactions, Gell-Mann-Nishijima formula.

Reference Books:

1. K. S. Krane, 1988, Introductory Nuclear Physics, Wiley, India.
2. D. C. Tayal, Nuclear Physics, Himalaya Publishing House.
3. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill.
4. I. Kaplan, 1989, Nuclear Physics, 2nd Edition, Narosa, New Delhi.
5. S. N. Ghoshal, Atomic and Nuclear Physics, S.Chand.
6. E. Segre, Nuclei and Particles
7. R. D. Evans, The Atomic Nucleus, Tata McGraw Hill.
8. G. F. Knoll, Radiation Detection and Measurement, 3rd edition, Wiley India.
9. S. S. Kapoor and V. S. Ramamurthy, Nuclear Radiation Detectors, Wiley eastern Limited.
10. R. R. Roy, B. P. Nigam, Nuclear Physics-Theory and Experiment,Wiley eastern Limited.
11. Frauenfelder and Henley, Subatomic Physics, Prentice Hall.
12. S. Sharma, Atomic & Nuclear Physics, Pearson education 2008
13. S. B. Patel, Nuclear Physics An Introduction, (New Age International Limited)

M. Sc-II (Physics) Semester-IV

PHY 5402: MATERIAL SCIENCE

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

On successful completion of this course students will be able to do the following

1. Qualitatively describe the bonding scheme and its general physical properties, as well as possible applications.
2. Describe physical origin of defects and its effects on various mechanical, electrical, thermal and other properties of the materials. Describe resultant elastic properties in terms of its 1D and 2D defects.
3. Understand diffusion mechanisms and solve problems related to diffusion processes.
4. Derive various metallurgical thermodynamics equations and functions.
5. Understand and apply Gibb's phase rule to various systems of materials.
6. Understand alloy systems, families of engineering alloys
7. Understand thermodynamic origin of phase diagrams, draw phase diagrams and understand phase diagrams and also apply their knowledge of phase diagrams for various applications.
8. Understand Phase transformation mechanisms.

Unit 1: Properties of Materials and Defects in Solids **(15L)**

(a) Mechanical, electrical, magnetic, thermal and structural properties (in brief – 2L only)

(b) Point defects - Vacancies, interstitials, non-stoichiometry, substitution, Schottky and Frenkel defects with proofs

(c) Line defects - Edge and screw dislocations, properties of dislocations – force on dislocation, energy of dislocation, pinned dislocation (These properties with derivation), dislocation density, interaction between dislocations, motion of a dislocation (cross-slip and climb), dislocation generator (Frank Read source)

(d) Surface defects – grain boundaries with explanation of high angle, low angle, tilt and twist boundaries, stacking fault

(e) Volume defect- twin boundary

(f) Solid Solution - Types of solid solutions (Substitutional and Interstitial), Factors governing solid solubility (Hume - Rothery rule), Atomic size and size factor in solid solutions, Vegard's law

Unit 2: Diffusion in Solids (15L)

Introduction, types of diffusion, Diffusion mechanism, Fick's first and secondlaws of diffusion, solution to Fick's second law (without proof, introduction of error function), Factors governing diffusion, Factors affecting diffusion coefficient (D), Experimental determination of D,Diffusion in oxides and ionic crystals, Applications of diffusion: Corrosion resistance of duralumin, Decarburization of steel, Doping of semiconductors

Unit 3: Metallurgical Thermodynamics (15L)

Revision of laws of thermodynamics, Auxiliary thermodynamic functions, measurement of changes in enthalpy and entropy, Richard's rule, Trouton's rule, Chemical reaction equilibrium, Thermodynamic properties of solutions (mixing processes – Rault's law, activity coefficient; regular solution behavior – Henry's law), Gibb's phase rule: proof, explanation and application to single component (H2O) and binary phase diagram

Unit 4: Alloy systems, Phase diagrams and Phase transformations (15L)

Alloy: Introduction, Alloy systems, Families of engineering alloys

Phase diagrams: Thermodynamic origin of phase diagrams, Lever rule,Type I (Cu-Ni) phase diagram, Type II (explanation only) phase diagram, Type III (Pb-Sn) phase diagram, Maxima and minima in two-phase regions, Miscibilitygaps, Topology of binary phase diagrams (Explanation in short of eutectic, peritectic, Monotectic, eutectoid, peritectoid, syntactic reaction, extension rule), Applications of phase diagrams

Phase transformation: Introduction, Mechanism of Phase Transformation, The kinetics of Solid state reaction, Nucleation and Growth, Applications of phase transformations

Reference books:

1. Elements of Materials Science and Engineering (5^{th} edition) - Lawrence H. Van Vlack, Addison - Wesley Publishing Co.
2. Materials Science and Engineering - V. Raghvan
3. Physical Metallurgy (PartI) R. W. Cahn and P. Hassen, North Holland Physics Publishing, New York
4. Introduction to Materials Science for Engineers (6th edition) - J.F. Shaekel ford and M. K. Murlidhara - Pearson Education
5. Materials Science – Kodgire and Kodgire
6. Materials Science – S L Kakani, Amit Kakani

M. Sc-II (Physics) Semester-IV

CB Group –III: 1. PHY 5403: PHYSICS OF THIN FILM-II

Credit: 04 **Total No. of Lectures: 60**

After completion of the course, the student should be able to:

1. Identify the signals and systems
2. Apply the principles of discrete-time signal analysis to perform various signal operations
3. Apply characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials
4. Determine crystal structure of sample and estimate its crystallite size

Unit 1: Radiation Sources, Detectors and Sensors (15L)

Sources of Electromagnetic Radiations: Different types of radiations (x-rays, rays, UV-VIS, IR, microwaves and nuclear) and their sources

Detectors: γ-rays, X-rays, UV-VIS, IR, microwaves and nuclear detectors

Sensors: Sensor's characteristics, Classification of sensors, Operation principles of sensors such as electric, dielectric, acoustic, thermal, optical, mechanical, pressure, IR, UV, gas and humidity with examples

Unit 2: Structural Characterization and Thermal Analysis (15L)

X-ray Diffraction – Production of X-rays, Types (continuous and characteristics), Bragg's diffraction condition, principle, instrumentation (with filters) and working, Techniques used for XRD – Laue's method, Rotating crystal method, Powder (Debye Scherrer) method, Derivation of Scherrer formula for size determination Neutron Diffraction: Principle, Instrumentation and Working

Thermal analysis: Principle, Instrumentation and Working: Thermo-gravimetric (TGA), Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), Graphical analysis affecting various factors, Numericals

Unit 3: Morphological and Magnetic Characterization (15L)

Optical Microscopy: Principle, Instrumentation and Working of optical microscope

Electron Microscopy: Principle, Instrumentation and Working of Scanning Electron Microscope (SEM), Field Emission Scanning Electron Microscope (FESEM) – Advantages over SEM, Transmission Electron Microscope (TEM), Selected Area Electron Diffraction (SAED)

Probe Microscopy: Principle, Instrumentation and Working of Scanning Tunneling

Microscope (STM) and Atomic Force Microscope (AFM)

Magnetic Characterization: Principle, Instrumentation and Working of Vibrating Sample Magnetometer (VSM), Analysis of Hysteresis loop, SQUID Technique: Principle, Instrumentation and Working. Numericals

Unit 4: Spectroscopic Analysis (15L)

Spectroscopic characterization (principle, instrumentation and working): Infra Red (IR), Fourier Transform Infra-Red (FTIR), Ultraviolet-Visible (UV-VIS), Diffused Reflectance Spectroscopy (DRS), X-ray Absorption (XPS), Electron Spin Resonance (ESR), Nuclear Magnetic Resonance (NMR). Numericals.

Reference Books:

1. Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
2. Instrumentation: Devices and Systems, C.S. Rangan, G.R. Sarma and V.S.V. Mani, Tata Mc Graw Hill Publishing Co. Ltd.
3. Instrumental Methods of Chemical Analysis, G. Chatwal and S. Anand, Himalaya Publishing House
4. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt, J.A. Dean, CBS Publishers
5. Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)
6. Elements of X-ray diffraction, Bernard Dennis Cullity, Stuart R. Stock, (Printice Hall, 2001 - Science - 664 pages)

M. Sc-II (Physics) Semester-IV

CB Group –III: 2. PHY 5403: NANO TECHNOLOGY-II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

After completion of the course, the student should be able to:

1. Students will be able to learn about the background on Nanoscience
2. Students will be able to understand the synthesis of nano materials and their application and the impact of nano materials on environment
3. Students will be able to apply their learned knowledge to develop Nanomaterial's.
4. Students will be able to apply principles of basic science concepts in understanding, analysis and prediction of matter at Nano scale.
5. Students will be able to introduce advanced ideas and techniques required in emergent area of nano technology.
6. Students will be able to understand and apply mathematical techniques for describing and deeper understanding of nano systems.

Unit 1: Optical and electrical Properties of Nano materials **(15L)**

Electronic Properties of Nano materials

Electronic Structure of Nanoparticles, Zero dimensional, one-dimensional and two dimensional nanostructures, Fundamentals of electrical conductivity in nano tubes and nano rods, carbon nano tubes, Photo conductivity of nano rods, electrical conductivity of nano composites

Optical properties of Nano materials

Absorption: direct and in direct band gap transitions, Emission: photoluminescence and Raman scattering,

Emission: chemiluminescence and electroluminescence, shape dependent optical properties

Unit 2: Nano structured Applications **(15L)**

Solar cells:

Generations of Solar cells, Dye sensitized solar cells, Advantages and disadvantages, Quantum dot sensitized solar cells, Perovskite solar cells

Batteries and Supercapacitors:

Basics of electrochemical cell, Primary batteries, Rechargeable batteries, Battery parameters (Battery capacity, Battery voltage, Battery life cycle, Discharge/charge rate), Lithium batteries, Chemistry and Physics of lithium batteries, Anode and cathode materials, Applications. Supercapacitors: Similarities and differences between supercapacitors and batteries, Energetics, Double layer electrostatic capacitor, Pseudo capacitance, Origin, Kinetic theory, Regon plot, Energy density and Power density, Various oxides as pseudocapacitors.

Fuel cell –

Principle, construction, types and applications

Unit 3: Characterizations of Thin Films **(15L)**

Thickness Measurement Methods: Weight Difference Method

Characterization Methods: X-ray diffraction (XRD), Scanning Electron Microscopy (SEM) and Energy, Field emission scanning electron microscopy (FESEM), Transmission electron microscopy (TEM), dispersive analysis of X-rays (EDAX), UV-VIS spectroscopy, X-ray photoelectron spectroscopy (XPS),

Scanning Tunneling Microscopy (STM), Atomic Force Microscopy (AFM)

Unit 4: Nano toxicology and Bio safety **(15L)**

Introduction, source of nanoparticles, epidemiological evidences, entry routes for nanoparticles in human body: lungs, intestinal tract and skin

Mechanisms of nano material toxicity: oxidative stress, eco toxicity, genotoxicity, hemolytic toxicity, mutagenicity and immunotoxicity

References:

1. Nanotechnology principle and practices by Sulabha K. Kulkarni (2007).
2. Handbook of Nanotoxicology, Nanomedicine and Stem Cell Use in Toxicology. Saura C Sahu, Daniel A Casciano.
3. Nanotoxicology - Interactions of Nanomaterials with Biological Systems. Yuliang Zhao and Hari Singh Nalwa.
4. Biointeractions of Nanomaterials. Vijaykumar B. Sutariya, Yashwant Pathak
5. New Technologies for Toxicity Testing. Michael Balls DPhil, Robert D. Combes PhD, Nirmala Bhogal.

M. Sc-II (Physics) Semester-IV

CB Group –III: 3. PHY 5403: BIOMEDICAL INSTRUMENTATION-II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

After completion of the course, the student should be able to:

1. Analyse and evaluate the effect of different diagnostic and therapeutic methods, their risk potential, physical principles, opportunities and possibilities for different medical procedures.
2. Understand and describe the physical and medical principles used as a basis for biomedical instrumentation.

Unit 1: Fundamentals to Biomedical Instrumentation and patient safety (15L)

1.1 Basic medical instrumentation system.

1.2 System configuration

1.3 basic characteristics of measuring system

1.4 Problems faced when measuring a human body

1.5 Essentials of biomedical instrumentation.

1.6 Electric shock hazards-Gross shock-Micro current shock

1.7 Precautions to minimize electric shock hazards

Unit 2: Electrodes and physiological transducers (15L)

3.1 Electrode Theory

3.2 Biopotential Electrodes

3.3 Electrodes for ECG, EEG, EMG.

3.4 Introduction to physiological transducers

3.5 Classification of Transducer

3.6 Performance characteristic of transducer.

3.7 Displacement, position and motion transducer.

3.8 Pressure transducer

3.9 Transducer for Body temperature measurement

3.10 Biosensors

Unit 3: Recording Systems and Signal Analysis: **(15L)**

3.1 Basic recording system.

3.2 General consideration for signal conditioners

3.3 Preamplifiers, Differential, Instrumentation, Isolation amplifier.

3.4 Source of noise in low level measurement.

3.5 Biomedical signal analysis techniques

3.6 Fourier Transform, FFT and Wavelet Transform

3.7 Signal processing techniques.

Unit 4: Cardiovascular System and Measurements **(15L)**

4.1 The Heart.

4.2 The Heart and Cardiovascular system

4.3 Blood Pressure

4.4 Heart Sounds

4.5 Block diagram of electrocardiograph

4.6 The ECG leads

4.7 Effect of Artifacts on ECG recording

4.8 Introduction to pacemakers

4.9 Types of pacemakers

4.10 Need for pacemakers

4.11Pacemaker system and its functioning

Reference Books:

1. 1.Biomedical Instrumentation and Measurements (Second edition)
   By Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer Pearson education.
2. Handbook of Biomedical Instrumentation (Second Edition) by R. S. Khandpur (Tata McGraw Hill).
3. Biomedical Instrumentation and Measurement by Carr and Brown-Pearson.

M. Sc-II (Physics) Semester-IV

CB Group –IV: 1. PHY 5404: ELECTRONIC INSTRUMENTATION-II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes:

After completion of the course, the student should be able to:

1. Understand the use of block diagrams & the mathematical basis for the design of control systems
2. Design and tune process (PID) controllers;
3. Understand the importance and application of good instrumentation for the efficient design of process control loops for process engineering plants.

Unit 1: Introduction to Process Control **(15L)**

1.1 Introduction, Control systems
1.2 Process control block diagram
1.3 Control system Evaluation and Control system Objective
1.4 Evaluation Criteria, Damped response, Cyclic response
1.5 Process Control Drawing and symbols with their meaning
1.6 Discrete Process Control : Introduction, definitions of discrete state process control
1.7 Characteristics of the systems , relay, controllers and ladder diagrams
1.8 PLC's, interfacing with LAN, SCADA systems

References: 1

Unit 2: Controller Principles **(15L)**

2.1 Introduction of controller
2.2 Process Characteristics- Process Load, Transient, Process Lag
2.3 Control System Parameters, Error, Variable Range, Control Parameter Range, Control Lag, Dead Time, Cycling
2.4 Controller Modes, Reverse And Direct Action, Discontinuous Controller Modes Two Position Neutral Zone (Examples) Applications
2.5 Multi position controller floating control mode- (eliminate single speed and multiple speed) Continuous controller modes, Proportional Control Mode, Integral Control Mode, Derivative Control Mode, Composite Control , PI Control, PD Control Mode, Three Mode Controller (PID)

References: 1

Unit 3: Controllers **(15L)**

3.1 Analog Controllers: Electronic controller with design considerations: Proportional (P), Integral (I), Derivatives (D) PI, PD and PID
3.2 Digital Control: Introduction two position controls and multivariable alarms.

References: 1

Unit 4: Modeling, Simulation and Programming **(15L)**

4.1 Introduction to modeling and simulation: Mathematical model, equivalent circuit model, Empirical Model, methodology, concept and need of simulation and its applications.

4.2 Introduction to MATLAB/ SciLab

References: 2 and References: 3

References Books:

1. Process Control Instrumentation Technology, Curtis D. Johnson, 7th Edition, Prentice Hall India Pvt. Ltd.
2. Computer based industrial controls K. Kant PHI publications.
3. MATLAB an introduction and applications", by Amos Gilat, Wiley Students Edition

M. Sc-II (Physics) Semester-IV

CB Group –IV: 2. PHY 5404: LASER-II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes

After completion of the course, the student should be able to:

1. Demonstrate competence in the use of various procedures and instruments for the assembly and characterisation of laser systems.
2. Demonstrate an awareness of the safety responsibilities involved in working with lasers.

Unit 1: Laser characteristics and Resonators (15L)

Principles, Properties of laser radiation, Light amplification, Threshold condition for laser oscillations, Homogeneous and inhomogeneous broadening, Laser rate equations for 2,3 and 4 level, variation of laser power around threshold, optimum output coupling, Open planar resonator, Quality Factor ,ultimate line width of the laser, Transverse and Longitudinal mode selection.

Unit 2: Non linear optics (15L)

Techniques for Q-switching, Mode Locking, Hole burning and Lamb dip in Doppler broadened Gas laser, Non linear oscillator model, Non linear polarization and wave equation, perturbative solution of the Nonlinear oscillator equation, Harmonic generation, Second harmonic generation, Phase matching third harmonic generation, Optical wave mixing, parametric generation of light, parametric oscillation, tuning of parametric oscillators, Non-Linear susceptibilities, non-linear susceptibility tensor, non-linear materials.

Unit 3: Applications of Laser Systems (15L)

Laser in industry, Lasers in Medicine**,** Lasers in Communications, Lasers in Science and Technology, Lasers in defense

Unit 4: Spectroscopic Instrumentation and applications (15L)

Raman scattering, photo acoustic Raman Spectroscopy, Raman Amplification and Raman laser, special techniques in non linear spectroscopy, polarization spectroscopy, multi-photon spectroscopy, photo fluoroscence excitation spectroscopy, Spatial Frequency filtering, optical computers, Laser ablation, Laser in Biomedicine.

References:

1. B. Laud, Laser and Non linear optics, Wiley Eastern Ltd., (1991)
2. A.K. Ghatak and K. Thyagarajan, optical electronics, Cambridge University Press S.C Gupta Optoelectronic devices and systems, Prentice Hall of India.
3. (WH) Wilson and Hawkes: Optoelectronics, Prentice Hall of India.
4. Yariv, Optical Electronics in Modern Communications, Oxford University Press (1997),
5. Laser Spectroscopy Basic concepts and instrumentation by Demtroder (ed. 3, Springer)
6. Laser: Svelto
7. Optical electronics: Wariv.
8. Laser spectroscopy: Demtroder.
9. Non-linear spectroscopy: Etekhov.
10. Introduction to modern optics: G. R. Flowles.

M. Sc-II (Physics) Semester-IV

CB Group –IV: 3. PHY 5404: ENERGY STUDIES-II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes

After completion of the course, the student should be able to:

1. The course providing a basic understanding of theory and practice of various photovoltaic technologies and design concepts.
2. To understand the physical principles of the photovoltaic (PV) solar cell
3. Discuss the positive and negative aspects of solar energy in relation to natural and human aspects of the environment.

Unit 1: Photovoltaic converters **(15L)**

Interaction of solar radiations with semiconductors, photovoltaic effect, types of solar cell, equivalent circuit diagram of a solar cell, determination of series resistance (Rs) and shunt resistance (Rsh), ideal properties of semiconductor for use its solar cell, carrier generation and recombination, dark and illuminated characteristics of solar cell, solar cell output parameters: RL, Voc, Isc, Pm, FF, efficiency, performance dependence of a solar cell on band gap energy, diffusion length and carrier life time, Types of heterojunction, construction of energy band diagram of heterojunctions, origin of capacitance in a heterojunction, expression for junction capacitance, Mott – Schottky relation, problems.

Unit 2: Materials and Solar cell Technology **(15L)**

Fabrication technology of solar cell, Single, poly – and amorphous silicon, GaAs, CdS, Cu_2S, $CuInSe_2$, CdTe etc. technologies for fabrication of single and polycrystalline silicon solar cells, amorphous silicon solar cells and tandem cells, solar cell modules, photovoltaic systems, space quality solar cells, dye synthesized solar cell, perovskite solar cell, Different materials used in solar cells, problems

Unit 3: Photochemical Converters **(15L)**

Semiconductor – electrolyte interface, Helmholtz double layer, Gouy-Chapman model, Stern model, Principle of photoelectrochemical solar cells, conversion efficiency in relation to different material properties, photoelectrolysis cell, drivingforce of photoelectrolysis, alkaline fuel cell, semiconductor- septum storage cell, concept of photocatalysis and photoelectrocatalysis process, problems.

Unit 4: Thermoelectric Converters (15L)

Thermoelectric effects, solid state description of thermoelectric effect, Kelvin's thermodynamic relations, analysis of thermoelectric generators, basic assumptions, temperature distribution and thermal energy transfer for generator, co-efficient of performance for thermoelectric cooling, problems.

Reference Books:

1. Solar energy conversion: The solar cell, by Richard C. Neville.
2. Photoelectrochemical solar cells – Suresh Chandra
3. Solar energy conversion – A. E. Dixon and J. D. Leslie.
4. Solar cells – Martin A. Green
5. Heterojunction and metal – semiconductor junctions – A.G. Milnes and D. L.Feucht.
6. Solid state electronic devices - B.G. Streetman.
7. Principles of solar engineering – Frank Kreith and Janf Kreider.
8. Direct energy conversion (4th edition) – Stanley W Angrist

M. Sc-II (Physics) Semester-IV

CB Group –IV: 4. PHY 5404: MICROCONTROLLER– II

Credit: 04 **Total No. of Lectures: 60**

Learning Outcomes

After completion of the course, the student should be able to:

1. Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.
2. Evaluate assembly language programs and download the machine code that will provide solutions real-world control problems.

Unit 1: Introduction to processors: **(15L)**

Introduction of Microprocessors and Microcontrollers, Introduction of Arduino Microcontrollers

Unit 2: Introduction to architecture: **(15L)**

Atmega328: Basics and Architecture, Instruction Set

Unit 3: Arduino programming: **(15L)**

Arduino programming basics, Analog/Digital components and its application with Arduino, IDE for Arduino

Other utilities in Arduino: Timers, Analog comparators and hardware interrupts

Unit 4: Interfacing with peripherals: **(15L)**

Communication buses, Interfacing of I/O devices

Case studies: Case studies of a few projects using Arduino boards and Shields

References:

1. Brian Evans, "Beginning Arduino Programming", Springer, 2011
2. Michael J. Pont , "Embedded C", Pearson Education, 2nd Edition, 2008
3. Raj Kamal, " Embedded Systems – Architecture: Programming and Design", TMH
4. Frank Vahid and Tony Givargis, "Embedded System Design", Wiley

M. Sc-II (Physics) Semester-III & IV

PHY 5305: SPECIAL LAB– I /PHY 5405: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –I: 1. PHY 5303: PHYSICS OF THIN FILM-I &

CB Group –III: 1. PHY 5403: PHYSICS OF THIN FILM-II):

Students have to perform minimum 5 Experiments in each Semester:

1. Students will be able to understand the synthesis of nano materials and their application
2. Students will able to explain different physical and chemical properties of material
3. Students will able to explain relation between nanotechnology and biology
4. Students will able to discuss the various applications that can be expected from nanotechnology
5. Students will able to determine the characterization techniques for nano materials and nano thin films can classify different techniques depending on application area.

1	Deposition of metallic thin films by vacuum evaporation method
2	Deposition of thin films by spray pyrolysis method and thickness measurement by gravimetric method
3	Thin film formation by Electro-chemical deposition technique.
4	Deposition of thin films by spin coating method and resistance measurement.
5	Deposition of thin film by Dip Coating method and thickness measurement.
6	Thickness measurement of thin film by Tolansky method.
7	Study of optical absorption of thin film (UV-visible spectroscopy) and determination of particle size
8	Determination of particle size of thin film from X-ray diffraction.
9	Determination of grain size of thin film from SEM
10	Resistivity measurement of thin film by two probe method
11	Band gap energy of thin film
12	Crystal structure of thin film
13	Electron Spin Resonance (ESR)
14	Development of microstructures by photolithography.

M. Sc-II (Physics) Semester-III & IV

PHY 5305: SPECIAL LAB– I /PHY 5405: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –I: 2. PHY 5303: NANO TECHNOLOGY-I &

CB Group –III: 2. PHY 5403: NANO TECHNOLOGY-II):

Students have to perform minimum 5 Experiments in each Semester:

1	Synthesis of Fe_2O_3 by sol-gel method
2	Preparation of Mn_3O_4 thin film by SILAR method
3	Synthesis of metal oxides by spray pyrolysis method
4	Synthesis of metal nanoparticles using green route
5	Band gap energy Measurement of thin films by UV-Visible spectrophotometer
6	Use of FT-IR for functional group identification (in CNT, graphene etc.)
7	Data plotting using Origin 8 software
8	Photoluminescence study of nano materials
9	Thickness measurement of thin film by weight difference method
10	Electro-deposition of Cu nano particle
11	Deposition of thin films by CBD method
12	Synthesis of ferrites by Co-precipitation method
13	Preparation of film by Doctor Blade method
14	Resistivity measurement of thin film by two probe method
15	Contact angle measurement of thin films
16	Structural properties of nano materials by XRD
17	Analysis of surface morphology by TEM
18	Morphological study by SEM

M. Sc-II (Physics) Semester-III & IV

PHY 5305: SPECIAL LAB– I /PHY 5405: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –I: 3. PHY 5303: BIOMEDICAL INSTRUMENTATION-I &

CB Group –III: 3. PHY 5403: BIOMEDICAL INSTRUMENTATION-II):

Students have to perform minimum 5 Experiments in each Semester:

1	Active filters for Bio-signals: Design and Filtering (Low pass and High pass filter)
2	Design and build a Notch filter (To reduce noise of 50 Hz).
3	ECG preamplifier-Instrumentation amplifier and testing.
4	Use of sphygmomanometers for measurement of blood pressure.
5	Concept of ECG, system and placement of electrodes ECG signal recording with surface Electrodes
6	Design and build a Wide/ Narrow band pass filters for measurement for Bio-signals
7	To study LVDT Characteristics.
8	Measurement of physical parameter using embedded system

M. Sc-II (Physics) Semester-III & IV

PHY 5306: SPECIAL LAB– I /PHY 5406: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –II: 1. PHY 5304: ELECTRONIC INSTRUMENTATION-I&

CB Group –IV: 1. PHY 5404: ELECTRONIC INSTRUMENTATION-III) :

Students have to perform minimum 5 Experiments in each Semester:

1	Application of ultrasonic pressure transducer.
2	Temperature Characteristic of Thermistor
3	D to A converter circuit (R-2R & binary weighted).
4	V to F, converter as basic concept of ADC.
5	Op-amp as Instrumentation amplifier.
6	Characteristics and applications of photoelectric devices, LED, Photodiode
7	Study of Sample and Hold Circuits
8	F to V Converter using OP-AMP
9	Study of Data Acquisition System
	Measurement of temperature by thermocouple
11	Measurement of displacement using LVDT
12	Temperature Characteristic of strain gauges and its Application
13	Logarithmic amplifier using op-amp 741
14	Measurement of load using strain gauge based load cell
15	Measurement of temperature by RTD
16	Study of storage oscilloscope and determination of transient response of RLC Circuit
17	Determination of characteristics of a fiber-optic sensor
18	Study of data acquisition system using “lab view” software and test all signal points
19	Measurement of water level using strain gauge based water level transducer
20	Study of P, PI and PID controllers

M. Sc-II (Physics) Semester-III & IV

PHY 5306: SPECIAL LAB– I /PHY 5406: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –II: 2. PHY 5304: LASER-I &

CB Group –IV: 2. PHY 5404: LASER-II):

Students have to perform minimum 5 Experiments in each Semester:

1	To study the diffraction patterns of single and double slit using laser source and measure its intensity variation using photo sensor and compare with incoherent source- Na light
2	Determine the wavelength of laser.
3	Thickness of sharp blade by LASER diffraction.
4	Study of laser beam diversity.
5	Determine of angle of divergence of a laser beam using He-Ne laser.
6	Determine of particle of size of lycopodium powder using semiconductor laser.
7	Determine the wavelength of laser light using semiconductor laser diffraction.
8	Determine the thickness of thin wire using LASER
9	Determine the wavelength of laser and calculate velocity and frequency of light.
10	Diffraction grating.

M. Sc-II (Physics) Semester-III & IV

PHY 5306: SPECIAL LAB– I /PHY 5406: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –II: 3. PHY 5304: ENERGY STUDIES-I &
CB Group –IV: 3. PHY 5404: ENERGY STUDIES-II):

Students have to perform minimum 5 Experiments in each Semester:

1	Solar Cell Characteristics
2	Recording the amount of sunlight receives throughout a day using Sunshine Recorder
3	Measure the solar radiation flux density using Pyrometer
4	Determining efficiency of lighting system/loads
5	Air mass Ratio
6	Bio-gas Production from Kitchen waste.
7	Energy Content in Wind.
8	Utilizing the latent heat released by the condensing water steam using Solar Still
9	Study of solar hot air collector/ solar dryer
10	Performance evaluation of box type and concentrating type solar cooker
11	Flat Plate Collector
12	PV – IV Characteristics
13	Find out the kinetics of photocatalytic reaction
14	Electrodeposition method

M. Sc-II (Physics) Semester-III & IV

PHY 5306: SPECIAL LAB– I /PHY 5406: SPECIAL LAB– II

Credit: 04

List of Experiments:

(CB Group –II: 4. PHY 5304: MICROCONTROLLER– I &
CB Group –IV: 4. PHY 5404: MICROCONTROLLER– II):

Students have to perform minimum 5 Experiments in each Semester:

1	Use of Keil/Pinacle software.
2	Addition of two 16 bit numbers
3	Multiplication of two 8 bit numbers.
4	Write a program to find largest/smallest number in given block
5	Write a program to toggle bits of port 1 with delay which depends on value of number in R0
6	Memory block transfer from one location to another.
7	Find two's complement of given number.
8	LCD Interfacing
9	Keyboard Interfacing
10	ADC Interfacing
11	Temperature Sensor Using LM 35

M. Sc-II (Physics) Semester-III

PHY 5306: PROJECT– I

The student will have to perform the project course for the both semesters III and IV. The continuous evaluation of the project will be done during each semester. Student must complete 50% project work in semester III and evaluation will be done at the end of semester and credit will be assigned to the students according to their performance.

M. Sc-II (Physics) Semester-IV

PHY 5406: PROJECT– II

The final evaluation of the project work will be done at the end of semester IV. Student should submit the dissertation of the project work and face the vivo-vice of the project.