DEPARTMENT OF APPLIED PHYSICS

SCHEME OF INSTRUCTIONS AND SYLLABUS FOR POST GRADUATE STUDIES

M.Sc. Physics

Visvesvaraya National Institute of Technology, Nagpur

July 2016

MISSION AND VISION
OF
VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

MISSION

The Mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. V.N.I.T. is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

VISION

To contribute effectively to the national endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country, incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

DEPARTMENT OF APPLIED PHYSICS, V. N. I. T. Nagpur

Objective of the M.Sc.(Physics) Program:

The objective of M.Sc.(Physics) program is to imparts basic concepts in theoretical as well as practical aspects of physics, so that students are able to tackle physics problems. Beside this program lays thrust on fundamentals of core and applied subjects of Physics. This will be of great help for shaping a career in research, higher and technical education and industry.

Brief about PG programs:

There are two types of subjects: Core and Elective. Core courses are compulsory and some courses from Electives are to be taken to complete the required credits.

TABLE 1. CREDIT REQUIREMENTS FOR M.Sc. STUDIES

Postgraduate Core (PC)		**Postgraduate Elective (PE)**	
Category	Credit	Category	Credit
Departmental Core (DC)	58	Departmental Electives (DE)	5
Basic Science (BS)		Other Courses (OC)	00
Total	58	Total	5
Grand Total PC + PE			63

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 Lectures, 1 Tutorial and 0 Practical in a week. This subject will have eight credits (3x2 + 1x1 + 0x1 = 8). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a Grade. Each grade has got certain grade points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. SGPA & CGPA are:

$$\boldsymbol{SGPA} = \frac{\sum_{semester} (Course\ credits\ X\ Grade\ points) for\ all\ courses\ except\ audit}{\sum_{semester} (Course\ credits\ ) for\ all\ courses\ except\ audit}$$

$$\boldsymbol{CGPA} = \frac{\sum_{All\ semester} (Course\ credits\ X\ Grade\ points) for\ all\ courses\ with\ pass\ grade\ except\ audit}{\sum_{All\ semester} (Course\ credits\ ) for\ all\ courses\ except\ audit}$$

Students can Audit a few subjects. i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Scheme of Instructions for M. Sc.

Details of credits:

I Semester				II Semester			
Code	Course	L-T-P	Credits	Code	Course	L-T-P	Credits
Core				Core			
PHL511	Classical Mechanics	3-0-0	3	PHL521	Quantum Mechanics	3-0-0	3
PHL512	Electronics-1	3-0-0	3	PHL522	Electrodynamics	3-0-0	3
PHL514	Communication skill	2-0-0	Audit	PHL523	Electronics –II	3-0-0	3
PHP515	General Physics Lab	0-0-6	3	PHL524	Statistical Mechanics	3-0-0	3
PHL513	Mathematical Physics	3-0-0	3	PHL525	Thin Film Techniques	3-0-0	3
CSL501	Computer Programming	3-0-0	3	PHP526	Electronics Lab	0-0-6	3
CSP501	Computer Programming	0-0-2	1				
Total No. Of Credits :			**16**	**Total No. Of Credits :**			**18**
III Semester				**IV Semester**			
Code	Course	L-T-P	Credits	Code	Course	L-T-P	Credits
Core				Core			
PHL531	Solid State Physics	3-0-0	3	PHL534	Nuclear and Particle physics	3-0-0	3
PHL532	Atomic and Molecular Physics	3-0-0	3	PHL537	Nanomaterials	3-0-0	3
PHL533	Material Science	3-0-0	3	PHD502	Project Phase - II		4
PHP533	Material Science Lab	0-0-4	2				
PHD501	Project Phase – I		3				
Total No. Of Credits :			**14**	**Total No. Of Credits :**			**10**
Elective							
PHL536	Characterisation of Materials	3-0-0	3				
PHP536	Characterisation of Materials	0-0-4	2				

Total No. Of Credits : 5

Complete Course Credits : 63

Course Name: PHL511 – Classical Mechanics

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Revision of Newtonian mechanics, constraints, Generalized coordinates Lagrange's equations of motion, Noethers theorem. Hamilton's function and Hamilton's equation of motion, Legendre transform, Phase space, Phase trajectories, Principle of least action, Hamiltonian principle.

Two body central force problem, Kepler problem, Scattering, Virial theorem.

Non-inertial frames of reference and pseudo forces, Elements of rigid body dynamics. Small oscillations, Normal mode analysis, Normal modes of a harmonic chain. Principle and postulate of relativity, Lorentz transformation , Length contraction, Time dilation and the Doppler Effect, Relativistic invariance of physical laws.

Recommended Books:

1. Classical Mechanics, H. Goldstein, 2nd Edition, Narosa Pub.
2. Classical Mechanics, N.C.Rana and P.S.Joag ,Tata Mc-Graw Hill Publishing Company Limited, New Delhi.
3. Mechanics ,L.D Landau and E.M.Lifshitz, Pergamon press, 1960
4. Classical mechanics, K.R.Srinivasa Rao, Univesities Press, Delhi
5. Introduction to mechanics, D. Kleppner, R.J. Kolenkow, McGraw Hill

Course Name: PHL512 - Electronics-I

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:
Operational amplifiers: Differential amplifier using transistors, operational amplifier characteristics, negative feedback configuration, application circuits (inverter, non-inverter, adder, integrator, differentiator, waveform generator, comparator and Schmidt trigger).

Transistor as a switch, feedback in amplifier. Digital logic gates, combinational circuits, Digital techniques and applications, registers, counters and comparators.
A/D and D/A convertors, applications. Transducers (temperature, pressure, magnetic field, vibration, optical

and particle detectors), Impedance matching, amplification (op amp based, instrumentation amplifier, feedback) filtering and noise reduction, shielding and grounding.

Recommended Books:

1. Solid state electronic devices, B.G. Streetman, Prentice Hall of India, New Delhi, 1995
2. Microelectronics, J.Millman, Mc Graw Hill International, 1987.
3. Process control and instrumentation, C. D. Johnson, Prentice Hall of India, New Delhi, 2000.

Course Name: PHL516 - Mathematical Physics

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Linear vector spaces, eigen values and eigen vectors of matrices, linear ordinary differential equations of second order, special functions.
Fourier series and transforms, functions of a complex variable and residue calculus.
Partial differential equations (Laplace equation in two and three dimensions in rectangular and polar co-ordinates, wave equation).
Introduction to tensors and index notation, Introduction to group theory.

Recommended Books:

1. 'Mathematical Methods in the Physical Sciences' Mary L. Boas , Wiley.
2.Advance Engineering Mathematics , Kreyzig , Wiley India
3. Mathematical Physics, H.K.Dass
4. Mathematical methods for physicists, Arfken, Weber, the Maple vail Manufacturing group, Academic press, 5th edition.

Course Name: - PHL521 : Quantum Mechanics

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Basic principles of Quantum mechanics, probabilities and probability amplitudes, wave functions, probability density and probability current. Schrödinger equation, application to linear harmonic oscillator, rigid rotor, hydrogen atom.

WKB approximation, WKB wave function criterion for validity of approximation, application to bound state.
Time dependent perturbation , transition probabilities, Time independent perturbation, degenerate cases, Spin states of electron, Pauli's spin matrix.

Scattering theory, Born approximation, Scattering cross section.

Recommended books:

1.Quantum Mechanics, E.Merzbacher, John Wiley (Asia) 1999

2. Quantum mechanics, G. Aruldhas ,

3. A Textbook of Quantum Mechanics, P.M.Mathews and K.Venkatesan, Tata McGraw Hill 1977

4. Principles of Quantum Mechanics, R.Shankar, Springer (Indian edition)

5 Quantum Mechanics, B.H.Bransden, C.J.Jaochim, Longman Scientific and Technical publication.

Course Name: - PHL522: Electrodynamics

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus :

Gauss law, Laplace and Poisson's equation, induced charges, Green's theorem, Laplace equation, Boundary conditions and uniqueness theorem, method of images, multipole expansion.

Biot-Savart law, magnetic vector potential, magnetic field in matter.

Faraday's law, Maxwell's equations, conservation laws, electromagnetic wave in free space, wave equation, reflection, refraction and propogation of waves. Dipole radiation, electric and magnetic dipole radiation.

Fields at the surface of and within conductor, cylindrical cavity and wave guide, Modes in rectangular waveguide, Modes in dielectric waveguides.

Recommended Books:

1. Classical Electrodynamics, J.D. Jackson, 3rd edition., Wiley, 1999.
2. Introduction to Electrodynamics, D.J. Griffiths, 3rd edition, PHI, 2011
3. Classical Electricity and Magnetism, W.K.H. Panofsky and M. Phillips, 2nd ed.,Addison- Wesley, 1962.
4. Electricity and magnetism, A.S.Mahajan,A.A.Rangwala, Tata McGraw Hill publishing company limited

Course Name: - PHL523 : Electronics-II

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

IC fabrication

MOSFET characteristics, Homojunction and heterojunction devices, Microprocessor and Microcontroller basics.

Data interpretation and analysis. Precision and accuracy, error analysis, propagation of error,

Least squares fittings, Measurement and control, Signal conditioning and recovery.

Fourier transforms, lock-in detector, box-car integrator, Modulation techniques.

Photodiodes, LEDS, solar cells.High frequency devices

Recommended books:

1. Microprocessor architechture, Programming and Applications with 8085/8086, R.S.Gaonkar , Wiley Eastern

2. Physics of semiconductor Devices,s.M.Sze, Third edition, Wiley

3.Semiconductor Physics and Devices, S.S.Islam, Oxfod University Press

Course Name: PHL524 : Statistical Mechanics

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

First law, second law, entropy, Thermodynamic potential, Maxwell relations, chemical potential , Phase equilibria.
Macro & micro state, phase space, density distribution in phase space, micro canonical, canonical and grand canonical ensembles, partition function, free energy, calculation of thermodynamic quantities.

Classical statistical mechanics, Postulates, derivation of thermodynamic laws, equipartition theorem, classical ideal gas, Gibbs paradox, statistics of paramagnetism.

Quantum Statistics, Postulates, density matrix, ensemble, Third Law of Thermodynamics,
ideal gases, Liovillie's theorem. Equilibrium condition, classification of phase transitions, phase diagram, Claussius- Clapeyron equation, Van-der-Walls equation, second order phase transition, Ginzberg – Landau theory, Ising
model, ferromagnetism, law of mass action, diffusion , Brownian motion.

Maxwell – Boltzmann, Bose – Einstein, Fermi – Dirac distributions, Bose condensation, and introduction to non-equilibrium processes.

Recommended Books:

1.Statistical mechanics , Kerson Huang , Wiley India

2. Fundamentals of Statistical mechanics, B.B. Laud, New Age International

3. Statistical Physics, F Reif, Berkley Physics Course, Vol 5

4. Statistical Thermodynamics, M.C.Gupta, New Age International

5. Statistical Mechanics, J.K.Bhattacharya, Narosa publishing house

Course Name: PHL525 : THIN FILM TECHNIQUES

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

I) Thin Film Deposition
Brief introduction regarding different methods for thin film formation (Physical and chemical), nucleation and growth mechanism .
Chemical Methods:
II) Chemical bath deposition (CBD) method: Introduction, experimental set-up, basic requirements, basic mechanisms: ion-by-ion, hydroxide cluster and complex decomposition mechanism, deposition from acidic bath, effect of stirring, advantages and disadvantages, a case study of CdS deposition, size quantization in CD films. Brief idea about SILAR (Successive ionic layer adsorption and reaction) method, advantages over CBD.
III) Electrochemical deposition: Introduction, principle, Faradays laws of electrolysis, experimental set-up, electrode, electrolyte, additives, power supply, substrate, Classification of elctrodeposition: potentiostatic, galvanostatic and cyclic voltametry, Steps involved in electrodeposition process, Over potential term, nucleation and growth mechanism, advantages and disadvantages, a case study.
IV) Spray Pyrolysis: Principle, experimental set-up, preparative parameters: influence of temperature, precursor's solution, Model for films deposition: Atomization of precursor's solution, Aerosol transport, decomposition of precursor, advantages and disadvantages, a case study of SnO2 deposition.
V)Spin Coating: Introduction, experimental set-up, Modeling spin coating, advantages and disadvantages, a case study.
Physical methods: Introduction physical vapor deposition (PVD) and Chemical Vapor deposition (CVD)
VI) Evaporation Methods: Thermal Evaporation (vacuum evaporation), Flash evaporation, Laser evaporation, Molecular beam epitaxy
VII) Chemical Vapor Deposition: Basic aspects of CVD, reactions in CVD, Types of CVD: atmospheric pressure, low pressure, plasma enhanced CVD.
VII) Sputtering: Basic principle of sputtering process, brief regarding triode sputtering, ion beam sputtering
Reference books:
1. Thin Film Phenomenon, K. L. Chopra, Mc Graw Hill, 1969.
2. Hand Book of Thin Film Technology, L. I. Maissel and R. Glang Mc Graw Hill, 1969
3. Thin Film Processes. J. L. Vossen and W. Kem, (Academic Press, 1978)
4. The Material Science of Thin Films, M. Ohring (Academic Press, 1972)
5. Chemical Solution Deposition of semiconductor Films, Gary Hodes, Marcel Dekker Inc
6. Thin Film Deposition Using Spray Pyrolysis, J. Electroceramics, 14 (2005) 103-111
7. Preparation of Thin Films, Joy George, Marcel Dekker, Inc.
8. Handbook of semiconductor electrodeposition, R.K.Pandey, S.N.Sahu, S.Chandra
9. Spin Coating for rectangular substrates, A Thesis written by G. A. Luurtesema, University of California, Berkeley, 1997

Course Name: PHL531 : Solid State Physics
Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Crystal structure, Bravais lattice, crystal diffraction, concept of reciprocal lattice, bonding of solids, Defects in Solids, Phonons, lattice specific heat.

Free electron theory, Drude model of electrical and thermal conductivity, Electrons in periodic lattice, Bloch theorem, Band theory, Kronig-Penney model, Classification of solids.

Hall Effect, Effective mass, mobility, Einstein's relation, Generation –Recombination, continuity equation.

Superconductivity, Critical Magnetic field and critical current density, Meissner Effect, type-I and type-II superconductors, London's equations, Thermodynamics of the superconducting state, Entropy and Specific heat in the superconducting state, Ginzburg Landau Theory of superconductivity, BCS theory of superconductivity, Josephson junction.

Recommended Books:

1. Introduction to solid state physics, Charles Kittel, John Wiley and Sons.
2. Solid state physics, A. J. Dekkar, Prentice Hall of India.
3. Solid state physics, C.M.Srivastava.
4. Elementary Solid State Physics Principles and Applications: M. Ali Omar
5. Solid State Physics: S.O. Pillai.

Course Name: PHL532: Atomic and Molecular Physics

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus :

Vector model of atoms, term for equivalent and non-equivalent electron atoms, Hyperfine structure and width of spectral line, Spectra of alkali metals, Helium Atom Normal and anomalous Zeeman Effect, Paschen –Back effect,

Stark effect, line broadening mechanism, rotation and vibrational spectra of molecules.

Electronic spectra of molecules, Frank-Condon Principle, dissociation energy, rotational fine structure of electronic vibration transitions, Raman spectra Characterization techniques: NMR spectroscopy, ESR spectroscopy.
Lasers, Theory of optical resonant cavity, Q- switching and mode locking in Lasers, different types of Lasers.

Recommended Books:

1. Atomic Spectra,H.D.White , Tata McGraw Hill Publication.
2. Molecular structure & spectroscopy, G.Aruldhas; Prentice – Hall of India, New Delhi(2001)
3. Fundamentals of molecular spectroscopy, Colin N.Banwell & Elaine M.McCash, TataMcGraw –Hill publishing company limited, Fourth edition(2002).
4. Quantum Physics of atoms, molecules, solids nuclei & particles, Robert Eisberg, Robert Resnick, Second edition, John Wiely & sons(Asia) Ltd.(1985)
5.Physics of atoms and molecules, Bransden, Joachim, Longman publishing group

Course Name: PHL533 :Materials Science

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus :

Introduction to materials. The phase rule, single component system, Binary Phase diagrams Microstructural changes
during cooling, Lever Rule, Some typical phase diagrams, Time scale for phase changes, nucleation and growth, nucleation kinetics, growth kinetics and overall kinetics, Applications, Solidification and crystallization, the glass transition.

Fick's laws and their solutions, the Kirkendall effect, mechanisms of diffusion.

Types of polarization, complex dielectric constant, polar and non-polar materials, Dielectric breakdown, piezoelectricity, ferroelectricity, electroceramics, multilayer capacitors.

Magnetic parameters, classification of magnetic materials, Ferromagnetic materials, ferrites,

Applications of magnetic materials, Multiferroics

Recommended Books:

1. Materials Science and engineering: a first course, V. Raghavan fifth Edition(Prentice-Hall of India)2004.
2. Materials Science and Engineering – An Introduction, W.D. Callister Jr. (John Wiley & Sons,)1991.
3. Materials Science, J. C. Anderson, K. D. Leaver, R.D. Rawlings and J.M. Alexander, 4^{th} Edition, Chapman & Hall (1994).
4. Electrical Properties of Materials , seventh Edition l.Solymar and D. Walsh (Oxford Univ.Press Indian Edition) 2006
5. Essentials of Materials Science and Engineering, Askeland, Pradeep Phule, Thomson learning (India Edition)
6. Principles of Materials Science and Engineering, William Smith, McGraw-Hill Publication

Course Name: PHL534 : Nuclear and particle physics

Pre-requisites: Nil

Offered in: IV Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:
Basic nuclear properties: size, shape and charge distribution, spin and parity, binding energy, semi empirical formula, liquid drop model.

Nature of nuclear force, form of nucleon-nucleon potential, charge independence and charge symmetry of nuclear forces. Deuteron problem.

Evidence of Shell structure, single particle shell model, its validity and limitations, Rotational spectra, elementary ideas of alpha, beta and gamma decays and their selection rules, fission and fusion.Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

Classification of fundamental forces , Elementary Particles and their Quantum numbers, Gellmann-Nishijima formula, Quark model, baryons and mesons, C, P, T invariance, Application of symmetry arguments to particle reactions, Parity non-conservation in weak interaction, Relativistic kinematics.

Recommended Books :

1. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988

2. Atomic and Nuclear Physics, S.N.Ghoshal , Vol. 2., S.Chand publication

3. Introduction to high Energy Physics, P.H. Perkins, Addison-Wesley, London, 1982.

4. Introduction to Elementary Particles, D. Griffiths, Harper and Row, New York, 1987.

5. Introductory nuclear physics, Y.R. Waghmare, Oxford – IBH, Bombay, 1981.

6. Nuclear Physics, Kapaln, 2nd addition, Narosa, Madras, 1989.

7. Introduction to Nuclear Physics, F.A. Enge, Addison-Wesley, 1975

8. Nucleon interaction, G.E. Brown and A.D. Jackson, North-Holland, Amsterdam, 1976.

Course Name: PHL536 : Characterization of Materials

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus:

Generation of X-rays, Moseley's law, Absorption of X-rays, Absorption edge, Diffraction intensity, structure factor, Powder method, Rotation method, Filter, detectors and counters.

X- ray characterization of single crystal, polycrystalline, thin films, super-lattices and nanomaterials. Determination of crystal structure, lattice parameter and strain (Tensile and compressive), XRF

Basics electron diffraction. Basic principles of Scanning and Transmission electron microscope. Working and construction of Scanning electron microscope, electron gun, field emission, resolution, types of scans: line scan and area scan. Basics of EDS, Sample preparation, Factors influencing image. Working and construction of transmission electron microscope, analysis of image.

Principles and working of DTA, DSC, TGA and Dialtometry.

Basics UV- Visible Spectroscopy, Photoluminiscence, FTIR and Raman Spectroscopy.

Resistivity/Sheet Resistance of Semiconductors, Basics of linear four probe and Van der Pauw methods, I- V characteristics of metal – semiconductor, Thermoelectric measurements.

Recommended Books:

1. Elements of X- ray diffraction, B.D. Cullity, Addison- Wesely Publishing company, 1956.
2. Transmission electron microscopy: A text book of Materials Science, David Williams and C.B.Carter, 2009.
3. Scanning Electron Microscopy: Physics of Image Formation and Microanalysis: Ludwig Reimer, 1998.
4. Introduction to Thermal Analysis Techniques and Applications, Brown and M Ewert, 2001.
5. Electrical characterization of semiconductor materials and devices, M. Deen and F. Pascal, 2007.
6. Electrical Properties of Materials, D. Walsh and L. Solymar, 7th Edition, 2007.

PHP – 536: Characterization of Materials Laboratory (0 – 0 - 4)
Set of experiments based on above syllabus.

Course Name: PHL537 : Nanomaterials

Pre-requisites: Nil

Offered in: IV Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Syllabus :

Basic concept, quantum mechanical view of nanomaterials, surface energy, electrostatic stabilization, Zero-dimensional, one - dimensional and two- dimensional nanomaterials.

Synthesis of nanomaterials by physical methods, chemical methods, biological methods. structural characterization of nanomaterials : XRD, SAXS, SEM, TEM, SPM, gas adsorption, optical spectroscopy Electrical, optical, mechanical and magnetic properties of nanomaterials, applications of nanomaterials

Special nanomaterials: CNT, zeolites, aerogels, oxide polymer structure, porous silicon, Zno nanotube.

Recommended Books:

1. Nanostructures and nanomaterials Synthesis, properties and applications, Guozhong Cao, Imperical college press

2. Fundamentals and applications of nanomaterials, Zhen Guo Li Tan, Artech House (2009)

Course Name: PHP-515 General Physics Lab

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-6); Credits: 3]

Type of Course: Core

Course Assessment Method: Continuous Evaluation

List Of Experiments

1) To Study Plank's Constant using LED .
2) To Study I-V Characteristics of CdS Photo-resistor at constant irradiance and to measure Photocurrent as a function of irradiance at constant voltage
3) To Study of Faraday's Effect (Magneto Optics Effect) Apparatus using LASER and to find Verdet's Constant.
4) To determine refractive Index of Glass Plate by using Brewster's angle Apparatus
5) To determine resistivity of very low and high resistivity of different samples by using 4-Probe setup (Research Model):
6) To determine the Elastic Constants of Glass by Cornu's Interference Apparatus : Young's modulus and Poisson's ratio using Interference method
7) To find the velocity of Ultrasonic wave, Bulk Modulus, Compressibility of the given liquid by using Ultrasonic Diffraction Apparatus Laser Based (Acousto-Optic Effect)
8) To verify Magnetic moment constant Bohr Magneton and fundamental constant using Zeeman Effect Apparatus (Fabri-Perot Etalon)
9) To find excitation potential of electrons using Neon tube by Franck –Hertz's method (data logger).
10) To determine e/m of electron with the help of magnetron valve .
11) Transmission of AC voltage through coaxial cable & optical fiber using optical fiber communication kit.
12) Dependence of Solar Cell I-V Characteristics on Light Intensity and Temperature
13) Dark and Illuminated Current-Voltage Characteristics of Solar Cell
14) Spectral Response Measurement of Solar cell.

Course Name: PHP-533 Material Science Lab

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(0-0-4); Credits: 2]

Type of Course: Core

Course Assessment Method: Continuous Evaluation

List Of Experiments

1. To determine Magnetic Susceptibility of Paramagnetic Solution by Quincke's Tube.
2. To determine Magnetic Susceptibility of Solid Material by Gouy's Method.
3. To determine Lande's Factor of DPPH using Electron Spin Resonance Spectrometer.
4. To determine hall coefficient in Metals using Hall effect set up.
5. To study Thermoluminiscence of F-Centers in Alkali Halide Crystals.
6. To study the dependence of Hall Coefficient on temp. of semiconductor sample.
7. To study the variation of dielectric constant of PZT sample with temperature and to determine its curie temperature.
8. To study the variation of energy loss of ferromagnetic materials with temperature and to determine its curie temperature.
9. To study Meissner Effect and determine Critical Temp. using Superconductivity Kit.
10. To plot B-H Curve for given samples.
11. To determine resistivity and energy band gap of semiconductors using Four Probe method.
12. To determine the dielectric constant of the given solid and liquid dielectrics (Bakelite, glass, plywood, PZT and aromatic compounds).
13. To find the conductivity of given samples by Kelvin's bridge method.

Course Name: PHP-526 Electronics Lab.

Offered in: II Semester (Even Semester)

Scheme and Credit: [(0-0-6); Credits: 3]

Type of Course: Core

Course Assessment Method: Continuous Evaluation

List Of Experiments

1	To Design and Study Solid State Regulated Power Supply
2	To study the operation of single stage and multi stage RC coupled amplifier using BJT.
3	To calculate $A_{v,}$ $A_{1.,}$, R_o, and R_i of CE RC coupled Amplifier with potential divider biasing.
4	To plot the frequency response of RC coupled Amplifier.
5	Study of Op-amp in Unity Gain, Inverting and Non-Inverting mode.
6	Application of Op-amp (using Negative Feedback) as Difference, Summing amplifier and as Integrator , Differentiator.
7	Application of Op-amp(using Positive Feedback) as Function Generator (Triangular, Square and Ramp).
8	Study of Wien Bridge Oscillator and effect on output frequency with variation in RC combination.
9	Application of Op-amp as square wave Generator or Astable Multivibrator.
10	Design of Active Filters: First Order Low Pass, High Pass Butterworth, Band Pass and Band Reject Filters.
11	Design and Study of Multivibrator using IC 555
12	Study of the characteristics of FET and to evaluate: drain resistance, trans conductance, amplification factor and DC drain resistance.
13	To study and measure the frequency response of FET amplifier.