

Year	Semester	Course Type	Course Code	Course Title	Credit	L-T-P	Marks			
3	V	SEMESTER-V						CA	ESE	TOTAL
		DSE-1A		Discipline-1(Physics)	6	4-0-4/ 5-1-0	15	60	75	
		DSE-2A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75	
		DSE-3A		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75	
		SEC-3		TBD	2	1-1-0/ 1-0-2	10	40	50	
		Semester - 5 : Total				20				275
	VI	SEMESTER-VI								
		DSE-1B		Discipline-1(Physics)	6	4-0-4/ 5-1-0	15	60	75	
		DSE-2B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75	
		DSE-3B		Other Discipline/TBD	6	4-0-4/ 5-1-0	15	60	75	
		SEC-4		TBD	2	1-1-0/ 1-0-2	10	40	50	
		Semester - 6 : Total				20				275
	Total in all semester:					122				1700

CC = Core Course , **AECC** = Ability Enhancement Compulsory Course , **GE** = Generic Elective , **SEC** = Skill Enhancement Course , **DSE** = Discipline Specific Elective , **CA**= Continuous Assessment , **ESE**= End Semester Examination , **TBD**=To be decided , **CT** = Core Theory, **CP**=Core Practical , **L** = Lecture, **T** = Tutorial , **P** = Practical , **MIL** = Modern Indian Language , **ENVS** = Environmental Studies ,



DSC 1AP: Mechanics (Practical)

Credits 02

Practical:

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine g and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

Suggested readings:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

DSC-1B(CC-2): Electricity and Magnetism

Credits 06

DSC1BT: Electricity and Magnetism

Credits 04

Course Contents

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem - Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric ipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics.

Parallel plate capacitor completely filled with dielectric.

Magnetism:

Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials.

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

Maxwell's equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic electric medium, transverse nature of EM waves, polarization.

Suggested Readings:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

DSC1BP: Electricity and Magnetism

Credits 02

Practical:

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
 - (i) Measurement of charge and current sensitivity
 - (ii) Measurement of CDR
 - (iii) Determine a high resistance by Leakage Method
 - (iv) To determine Self Inductance of a Coil by Rayleigh's Method .
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem



- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

DSC1CP: Thermal Physics and Statistical Mechanics (lab)

Credits 02

Practical:

1. To determine Mechanical Equivalent of Heat, J , by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

Suggested Readings:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

DSC-1D (CC-4): Waves and Optics

Credits 06

DSC1DT: Waves and Optics

Credits 04

Course Contents

	The differential equation describing the motion of a pendulum is $\frac{d^2\vartheta}{dt^2} = -\sin(\vartheta)$ The pendulum is released from rest at an angular displacement α , i. e. $\vartheta(0) = \alpha$ and $\vartheta'(0) = 0$. Solve the equation for $\alpha = 0.1, 0.5$ and 1.0 and plot ϑ as a function of time in the range $0 \leq t \leq 8\pi$. Also plot the analytic solution valid for small ϑ ($\sin(\vartheta) = \vartheta$)
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Suggested Readings:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C++: The Art of Scientific Computing, W.H. Press et al., 3rd Edn., 2007, Cambridge University Press.
- A first course in Numerical Methods, Uri M. Ascher and Chen Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3rd edn. , 2007, Wiley India Edition.
- Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to Computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press

Or

DSE-1: Quantum Mechanics

Credits 06

DSE1T: Quantum Mechanics

Credits 04

Course Contents:

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigen values and Eigen functions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wave packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method.

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers l and m ; s, p, d,.. shells (idea only)

Atoms in Electric and Magnetic Fields:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields : - Normal and Anomalous Zeeman Effect.

Many electron atoms:- Pauli's Exclusion Principle. Symmetric and Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings.

Suggested Readings:

- A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldas, 2ndEdn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer

DSEIP: Quantum Mechanics (Practical)

Credits 02

Practical:

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited

state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{n^2} [v(r) - E] \text{ where } V(r) = \frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take $e = 3.795$ (eVÅ)^{1/2}, $\hbar c = 1973$ (eVÅ) and $m = 0.511 \times 10^6$ eV/c².

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{n^2} [v(r) - E]$$

Where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r} e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take $e = 3.795$ (eVÅ)^{1/2}, $m = 0.511 \times 10^6$ eV/c², and $a = 3\text{Å}, 5\text{Å}, 7\text{Å}$. In these units $\hbar c = 1973$ (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{n^2} [v(r) - E]$$

For the anharmonic oscillator potential

$$V(r) = \frac{1}{2} kr^2 + \frac{1}{3} br^3$$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose $m = 940$ MeV/c², $k = 100$ MeV fm⁻², $b = 0, 10, 30$ MeV fm⁻³ In these units, $\hbar c = 197.3$ MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2\mu}{n^2} [V(r) - E]$$

where μ is the reduced mass of the two-atom system for the Morse potential

$$V(r) = D (e^{-2ar'} - e^{-ar'}), \quad r' = \frac{r-r_0}{r_0}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: $m = 940 \times 10^6$ eV/c², $D = 0.755501$ eV, $\alpha = 1.44$, $r_0 = 0.131349$ Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect : with external magnetic field; Hyperfine splitting

Optical system of the body: Physics of the eye.

Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Physics of diagnostic and therapeutic systems-I

X-Rays: Electromagnetic spectrum, production of x-rays, x-ray spectra, Bremsstrahlung, Characteristic x-ray.

X-ray tubes & types: Coolidge tube, x-ray tube design, tube cooling stationary mode, Rotating anode x-ray tube, Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables, HT generation.

Radiation Physics:

Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose, inverse square law. Interaction of radiation with matter Compton & photoelectric effect, Rem & Sievert, linear attenuation coefficient.

Radiation Detectors:

Thimble chamber, condenser chambers, Geiger Muller counter, Scintillation counters and Solid State detectors, ionization chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors.

Medical Imaging Physics:

Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler.

Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy.

Computed Tomography Scanner- principle & function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display).

Radiation Oncology Physics:

External Beam Therapy (Basic Idea): Tele-cobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife.

Contact Beam Therapy (Basic Idea): Brachytherapy-LDR and HDR, Intra Operative Brachytherapy. Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines, Medical linear accelerator. Basics of Teletherapy units, deep x-ray, Telecobalt units, medical linear accelerator, Radiation protection,

external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume.

Radiation and Radiation Protection:

Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect.

Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter. Radiation dosimeter. Natural radioactivity, Biological effects of radiation, Radiation monitors. Steps to reduce radiation to Patient, Staff and Public. Dose Limits for occupational workers and Public.

AERB: Existence and Purpose.

Physics of Diagnostic and Therapeutic Systems - II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography.

Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment.

Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnoea and Cpap Machines, Ventilator and its modes.

Suggested Readings:

- Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley .
- Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi.
- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins.
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition.
- Physics of the human body, Irving P. Herman, Springer.
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, 2nd edn.
- Handbook of Physics in Diagnostic Imaging: R.S. Livingstone: B.I. Publication Pvt Ltd.
- The Physics of Radiology-H E Johns and Cunningham.

DSE1P: Medical Physics (Practical)

Credits 02

Practical:

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.

2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the Use of a Vascular Doppler.

Suggested Readings:

- Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi .
- Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins .
- Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition .
- The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition .
- The Physics of Radiology-H E Johns and Cunningham.
- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, Asia Publishing House.
- Handbook of Physics in Diagnostic Imaging: Roshan S. Livingstone: B. I. Publications Pvt Ltd.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, Kitab Mahal, New Delhi.

DSE-2: Solid State Physics

Credits 06

DSE2T: Solid State Physics

Credits 04

Course Contents:

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and

Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeier relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons.

Elementary band theory: Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect.

Suggested Readings:

- Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, Neil W. Ashcroft and N. David Mermin, 1976, Cengage Learning
- Solid State Physics, Rita John, 2014, McGraw Hill
- Solid-state Physics, H. Ibach and H Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

DSE2P: Solid State Physics (Practical)

Credits 02

Practical:

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) crystal with temperature by four probe method (from room temperature to 150 °C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Suggested Readings:



Suggested Readings:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, McGraw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, Prentice Hall.
- Electronic Principle, Albert Malvino, Tata Mc-Graw Hill.

Or

DSE-2: Nuclear & Particle Physics

Credits 06

DSE-2T: Nuclear & Particle Physics

Credits 06 (05+01)

Course Contents:

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excited states.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Radioactivity decay:(a) Alpha decay: basics of α -decay processes, theory of α - emission, Gamow factor, Geiger Nuttall law, α -decay spectroscopy. (b) β - decay: energy kinematics for β -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility).

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

Suggested Readings:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991)

Skill Enhancement Course (SEC)

SEC-1: Physics Workshop Skill

Credits 02

SEC1T: Physics Workshop Skill

Course Contents:

Introduction:

Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

Mechanical Skill:

Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothing of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

Electrical and Electronic Skill:

Control Statements:

Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using $\exp(x)$ series evaluated at $x=1$

Scientific word processing:

Introduction to LaTeX:

TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, changing the type style, Symbols from other languages.

Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and unctions), Understanding data with Gnuplot

SEC-1P: Practical

Credit 01

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.

Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

Generators and Transformers:

DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

Electric Motors:

Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

Solid-State Devices:

Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources

Electrical Protection:

Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

Electrical Wiring:

Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.

Suggested Readings:

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

Or

SEC-2: Basic Instrumentation Skills

Credits 02

SEC2T: Basic Instrumentation Skills

Credit 01

Course Contents:

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

SEC-4P: Practical

Credit 01

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
 - (a) To calculate the sunniest time of the year.
 - (b) To study the variation of rainfall amount and intensity by wind direction.
 - (c) To observe the sunniest/driest day of the week.
 - (d) To examine the maximum and minimum temperature throughout the year.
 - (e) To evaluate the relative humidity of the day.
 - (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Suggested Readings:

- Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
- The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
- Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
- Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.
- Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
- Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

2. Study of characteristics of GM tube and determination of operating voltage and plateau
3. length using background radiation as source (without commercial source).
4. Study of counting statistics using background radiation using GM counter.
5. Study of radiation in various materials (e.g. K₂SO₄ etc.). Investigation of possible
6. radiation in different routine materials by operating GM at operating voltage.
7. Study of absorption of beta particles in Aluminum using GM counter.
8. Detection of α particles using reference source & determining its half life using spark counter
9. Gamma spectrum of Gas Light mantle (Source of Thorium)

Suggested Readings:

- W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
- G.F.Knoll, Radiation detection and measurements.
- Thermoluminescence Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
- W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.
- Why J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981
- Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
- A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
- NCRP, ICRP, ICRU, IAEA, AERB Publications.
- W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981

OR

SEC-4: Applied Optics

Credits 02

SEC4T: Applied Optics

Credit 01

Course Contents:

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

a. Sources and Detectors: Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein’s coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

b. Fourier Optics: Concept of Spatial frequency filtering, Fourier transforming property of a thin lens.

c. Holography: Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

d. Photonics: Fibre Optics: Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Experiments:**Experiments on Lasers:**

- a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
- b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
- c. To find the polarization angle of laser light using polarizer and analyzer
- d. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

- a. V-I characteristics of LED
- b. Study the characteristics of solid state laser
- c. Study the characteristics of LDR
- d. Photovoltaic Cell
- e. Characteristics of IR sensor

Experiments on Fourier Optics:**a. Fourier optic and image processing**

- i. Optical image addition/subtraction
- ii. Optical image differentiation
- iii. Fourier optical filtering
- iv. Construction of an optical 4f system

b. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

d. Experiments on Holography and interferometry:

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

e. Experiments on Photonics: Fibre Optics:

- a. To measure the numerical aperture of an optical fibre
- b. To study the variation of the bending loss in a multimode fibre
- c. To determine the mode field diameter (MFD) of fundamental mode in a single- mode fibre by measurements of its far field Gaussian pattern
- d. To measure the near field intensity profile of a fibre and study its refractive index profile
- e. To determine the power loss at a splice between two multimode fibre

Suggested Readings:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books

- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press
