











## Core Courses (CC)

**DSC-1A(CC-1): Mechanics**

**Credits 06**

**DSC1AT: Mechanics**

**Credits 04**

### **Course Contents**

**Vectors:** Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

**Ordinary Differential Equations:** 1st order homogeneous differential equations. 2<sup>nd</sup> order homogeneous differential equations with constant coefficients.

**Laws of Motion:** Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

**Momentum and Energy:** Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

**Rotational Motion:** Angular velocity and angular momentum. Torque. Conservation of angular momentum.

**Gravitation:** Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

**Oscillations:** Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

**Elasticity:** Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia -  $q$ ,  $\eta$  and  $\sigma$  by Searles method

**Special Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of relativity. Length contraction. Time dilation. Relativistic addition of velocities.

### **Suggested Readings:**

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.



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



















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

- Introduction to Numerical Analysis, S.S. Sastry, 5<sup>th</sup> 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, 3<sup>rd</sup> 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, 2<sup>nd</sup> Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2<sup>nd</sup> Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3<sup>rd</sup> Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldas, 2<sup>nd</sup>Edn. 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, 2<sup>nd</sup> Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4<sup>th</sup>Edn., 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  $\approx -13.6$  eV. Take  $e = 3.795$  (eVÅ)<sup>1/2</sup>,  $\hbar c = 1973$  (eVÅ) and  $m = 0.511 \times 10^6$  eV/c<sup>2</sup>.

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)<sup>1/2</sup>,  $m = 0.511 \times 10^6$  eV/c<sup>2</sup>, 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/c<sup>2</sup>,  $k = 100$  MeV fm<sup>-2</sup>,  $b = 0, 10, 30$  MeV fm<sup>-3</sup> 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  $\mu$  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/c<sup>2</sup>,  $D = 0.755501$  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

7. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

**Suggested Readings:**

- 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., 3<sup>rd</sup> Edn., 2007, Cambridge University Press.
- Elementary Numerical Analysis, K.E.Atkinson, 3<sup>rd</sup> edn. , 2007, Wiley India Edition.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3<sup>rd</sup> Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer
- Scilab by example: M. Affouf 2012 ISBN: 978-1479203444
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company, New Delhi
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

Or

**DSE-1: Medical Physics**

**Credits 06**

**DSE1T: Medical Physics**

**Credits 04**

**Course Contents:**

**Physics of the Body-I**

**Basic Anatomical Terminology:** Standard Anatomical Position, Planes. Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal.

**Mechanics of the body:** Skeleton, forces, and body stability. Muscles and dynamics of body movement. Physics of Locomotors Systems: joints and movements, Stability and Equilibrium.

**Energy household of the body:** Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation.

**Pressure system of body:** Physics of breathing, Physics of cardiovascular system.

**Physics of the Body-II**

**Acoustics of the body:** Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound.

**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, 2<sup>nd</sup> 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.







**Sinusoidal Oscillators:** Barkhausen's Criterion for Self-sustained Oscillations.  
Determination of Frequency of RC Oscillator

#### **UNIT-4: Instrumentations**

Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation

Timer IC: IC 555 Pin diagram and its application as Astable & Monostable Multivibrator

#### **Suggested Readings:**

- Integrated Electronics, J. Millman and C.C. Halkias, Tata Mc-Graw Hill.
- Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, Tata Mc-Graw Hill.
- Microelectronic Circuits, M.H. Rashid, 2<sup>nd</sup>, Cengage Learning.
- Modern Electronic Instrumentation & Measurement Tech., elfrick & Cooper, PHI Learning
- Digital Principles & Applications, A.P. Malvino, D.P. Leach & Saha, 7th Ed., Tata McGraw Hill
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 6th Edn., Oxford University Press.
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, PHI Learning Pvt. Ltd.
- OP-AMP and Linear Digital Circuits, R.A. Gayakwad, PHI Learning Pvt. Ltd.

#### **DSE2P: Digital and Analog Circuits and Instrumentation (Practical) Credits 02**

##### **Practical:**

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Sub tractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of a given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study a precision Differential Amplifier of given I/O specification using Opamp.
14. To investigate the use of an op-amp as a Differentiator
15. To design a Wien Bridge Oscillator using an op-amp.







## 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.

**Electronic Voltmeter:** Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

**AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier-amplifier. Block diagram ac millivoltmeter, specifications and their significance.

**Cathode Ray Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

**Signal Generators and Analysis Instruments:** Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

**Impedance Bridges & Q-Meters:** Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

**Digital Instruments:** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

**Digital Multimeter:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time- base stability, accuracy and resolution.

## **SEC2P: Practical**

**Credit 01**

**The test of lab skills will be of the following test items:**

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

**Laboratory Exercises:**

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.









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. K<sub>2</sub>SO<sub>4</sub> 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  $\alpha$  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

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