SIES College of Arts, Science & Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

# SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE (Autonomous)

**Affiliated to**

## UNIVERSITY OF MUMBAI

## Syllabus for

## SEM I, II, III and IV

## Program: M.Sc.

## Course: Physics

**(Credit Based Semester and Grading System With effect from the academic year 2023-24)**

<u>**Course Structure & Distribution of Credits**</u>

**Semester I**

M.Sc. in Physics Program for Semester I consists of five theory courses and three Practical Lab courses. The details are as follows:

| **Theory Courses** | **16 hours per week (One lecture of one hour duration)** | | |
|---|---|---|---|
| Theory Papers | Subject | Lectures(Hrs.) | Credits |
| 1 | Mathematical Methods | 60 | 04 |
| 2 | Quantum Mechanics-I | 60 | 04 |
| 3 | Classical Mechanics-I | 30 | 02 |
| 4 | Research Methodology | 45 | 03 |
| 5 | Advance Electronics & RTOS | 45 | 03 |
| | **TOTAL** | **240** | **16** |

| **Practical lab courses** | **12 hours per week** | |
|---|---|---|
| **Practical Lab Course** | Practical Lab Sessions (Hrs.) per week | Credits |
| Lab Course-1 | 8 | 4 |
| Elective Lab Course-1 | 2 | 1 |
| Research Methodology | 2 | 1 |
| **TOTAL** | **12** | **6** |

**Semester II**

M.Sc. in Physics Program for Semester-II consists of four theory courses and three Practical Lab courses. The details are as follows:

| **Theory Courses** | **13 hours per week (One lecture of one hour duration)** | | |
|---|---|---|---|
| Theory Papers | Subject | Lectures(Hrs.) | Credits |
| 1 | Electrodynamics | 60 | 04 |
| 2 | Quantum Mechanics-II | 60 | 04 |
| 3 | Classical Mechanics-II | 30 | 02 |
| 4 | Microcontroller and Interfacing | 45 | 03 |
| | **TOTAL** | **195** | **13** |

| **Practical lab courses** | **18 hours per week** | |
|---|---|---|
| **Practical Lab Course** | Practical Lab Sessions (Hrs.) per week | Credits |
| Lab Course-2 | 8 | 4 |
| Elective Lab Course-2 | 2 | 1 |
| OJT | 8 | 4 |
| **TOTAL** | **18** | **9** |

## Semester III

M.Sc. in Physics Program for Semester III consists of three theory courses, two Practical Lab course and one Project course. The details are as follows:

| **Theory Courses** | **11 hours per week (One lecture of one hour duration)** | | |
|---|---|---|---|
| Theory Papers | Subject | Lectures(Hrs.) | Credits |
| 1 | Statistical Mechanics | 60 | 04 |
| 2 | Nuclear Physics | 60 | 04 |
| 3 | Advanced Microprocessor, Embedded system and RTOS | 45 | 03 |
| | **TOTAL** | **165** | **11** |

| **Practical lab courses** | **22 hours per week** | |
|---|---|---|
| **Practical Lab Course** | Practical Lab Sessions (Hrs.) per week | Credits |
| Lab Course-3 | 8 | 4 |
| Elective Lab Course-3 | 2 | 1 |
| Research Project-1 | 12 | 6 |
| **TOTAL** | **22** | **11** |

## Semester IV

M.Sc. in Physics Program for Semester IV consists of three theory courses, Two Practical Lab course and one Project course. The details are as follows:

| **Theory Courses** | **11 hours per week (One lecture of one hour duration)** | | |
|---|---|---|---|
| Theory Papers | Subject | Lectures(Hrs.) | Credits |
| 1 | Solid State Physics and Devices | 60 | 04 |
| 2 | Atomic and Molecular Physics | 60 | 04 |
| 3 | VHDL, USB and Communication Interface | 45 | 03 |
| | **TOTAL** | **165** | **11** |

| **Practical lab courses** | **22 hours per week** | |
|---|---|---|
| **Practical Lab Course** | Practical Lab Sessions (Hrs.) per week | Credits |
| Lab Course-4 | 8 | 4 |
| Elective Lab Course-4 | 2 | 1 |
| Research Project-2 | 12 | 6 |
| **TOTAL** | **22** | **11** |

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Mathematical Methods | 4 |

**Unit-I: COMPLEX ANALYSIS** **15 lectures**

Complex Variables, Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order m, Contour Integrals, Evaluation of improper real integrals, improper integral involving Sines and Cosines, Definite integrals involving sine and cosine functions.

**Unit-II: MATRICES** **15 lectures**

Matrices, Eigenvalues and Eigen vectors, orthogonal, unitary and Hermitian matrices, Diagonalization of Matrices, Application to Physics problems. Introduction to Tensor Analysis, Addition and Subtraction of Tensors, summation convention, Contraction, Direct Product, Levi-Civita Symbol.

**Unit-III: SPECIAL FUNCTIONS** **15 lectures**

General treatment of second order linear differential equations with non-constant coefficients, Power series solutions, Frobenius method, Legendre, Hermite and Laguerre polynomials, Bessel equations, Nonhomogeneous equation – Green's function, Sturm-Louiville theory.

**Unit-IV: INTEGRAL TRANSFORMS** **15 lectures**

Integral transforms: three dimensional fourier transforms and its applications to PDEs (Green function of Poisson's PDE), convolution theorem, Parseval's relation, Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem, use of Laplace's transform in solving differential equations.

**Main references:**


1. S. D. Joglekar, *Mathematical Physics*: The Basics, Universities Press 2005.
2. S. D. Joglekar, *Mathematical Physics*: Advanced Topics, CRC Press 2007.
3. M.L. Boas, *Mathematical methods in the Physical Sciences*, Wiley India 2006.
4. G. Arfken and H. J. Weber: *Mathematical Methods for Physicists*, Academic Press 2005.


**Additional references:**


1. A.K. Ghatak, I.C. Goyal and S.J. Chua, *Mathematical Physics*, McMillan.
2. A.C. Bajpai, L.R. Mustoe and D. Walker, *Advanced Engineering Mathematics*, John Wiley.
3. E. Butkov, *Mathematical Methods*, Addison-Wesley.
4. J. Mathews and R.L. Walker, *Mathematical Methods of physics*.
5. P. Dennery and A. Krzywicki , *Mathematics for physicists*.
6. T. Das and S.K. Sharma, *Mathematical methods in Classical and Quantum Mechanics*.
7. R. V. Churchill and J.W. Brown, *Complex variables and applications*, V Ed. Mc Graw. Hill.
8. A. W. Joshi, *Matrices and Tensors in Physics*, Wiley India.

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Quantum Mechanics-I | 4 |

**Unit-I: Fundamentals of Quantum Mechanics** **15 lectures**

Review of concepts: Postulates of quantum mechanics, observables and operators, measurements, state function and expectation values, the time-dependent Schrodinger equation, time development of state functions, solution to the initial value problem. The Superposition principle, commutator relations, their connection to the uncertainty principle, complete set of commuting observables. Time development of expectation values, conservation theorems and parity.

Formalism: Linear Vector Spaces and operators, Dirac notation, Hilbert space, Hermitian operators and their properties, Matrix mechanics: Basis and representations, unitary transformations, the energy representation. Schrodinger, Heisenberg and interaction picture.

**Unit-II: Solutions of 1D Schrodinger equation** **15 lectures**

**Wave packet:** Gaussian wave packets, Fourier transform.

**Schrodinger equation solutions: one dimensional problems:** General properties of one dimensional Schrodinger equation, Particle in a box, Harmonic oscillator by raising and lowering operators and Frobenius method, unbound states, one dimensional barrier problems, finite potential well.

**Unit-III: Schrodinger equation solutions: 3D problems** **15 lectures**

Orbital angular momentum operators in Cartesian and spherical polar coordinates, commutation and uncertainty relations, spherical harmonics, two particle problem-coordinates relative to centre of mass, radial equation for a spherically symmetric central potential, hydrogen atom, eigenvalues and radial eigenfunctions, degeneracy, probability distribution.

**Unit-IV: Angular Momentum** **15 lectures**

1. Ladder operators, eigenvalues and eigenfunctions of $L^2$ and $L_z$ using spherical harmonics, angular momentum and rotations.
2. Total angular momentum J; LS coupling; eigenvalues of $J^2$ and $J_z$.
3. Addition of angular momentum, coupled and uncoupled representation of eigen-functions, Clebsch Gordan coefficient for $j_1 = j_2 = {}^1/_2$ and $j_1 = 1$ and $j_2 = {}^1/_2$.
4. Angular momentum matrices, Pauli spin matrices, spin eigenfunctions, free particle wave function including spin, addition of two spins.

**Main references:**
1. Richard Liboff, *Introductory Quantum Mechanics*, 4$^{th}$ edition, Pearson.
2. D. J. Griffiths, *Introduction to Quantum Mechanics* 4$^{th}$ edition.
3. A. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications*, 5$^{th}$ edition.
4. N. Zettili, *Quantum Mechanics: Concepts and Applications*, 2$^{nd}$ edition, Wiley.

**Additional References:**
1. W. Greiner, Quantum Mechanics: An introduction, Springer, 2004.
2. R. Shankar, Principles of Quantum Mechanics, Springer, 1994.
3. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill (1977).
4. J. J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1994).

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Classical Mechanics - I | 2 |

**Unit-I: Lagrangian and Hamilton Formulation** **15 lectures**

Review of Newton's laws, Mechanics of a particle, Mechanics of a system of particles, Frames of references, rotating frames, Centrifugal and Coriolis force, Constraints, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and the dissipation function, Simple applications of the Lagrangian formulation. Hamilton's principle, Calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, Lagrange Multipliers and constraint extremization problems, Extension of Hamilton's principle to non-holonomic systems, Advantages of a variational principle formulation.

**Unit-II: Canonical Transformations** **15 lectures**

Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, Poisson brackets and other canonical invariants, Equations of motion, infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum Poisson bracket relations.

**Main Reference:** H. Goldstein, Poole and Safko, *Classical Mechanics*, 3rd Edition, Narosa Publication (2001).

**Additional References:**


1. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata McGraw Hill Publication.
2. S. N. Biswas, *Classical Mechanics*, Allied Publishers (Calcutta).
3. V. B. Bhatia, *Classical Mechanics*, Narosa Publishing (1997).
4. Landau and Lifshitz, Butterworth, *Mechanics*, Heinemann.
5. R. V. Kamat, *The Action Principle in Physics*, New Age Intnl. (1995).
6. Vol I and II, E. A. Deslougue, *Classical Mechanics*, John Wiley (1982).
7. *Theory and Problems of Lagrangian Dynamics, Schaum Series,* McGraw (1967).
8. K. C. Gupta, *Classical Mechanics of Particles and Rigid Bodies,* Wiley Eastern 2001).

**<u>Semester –I</u>**

| Course Code | Title | Credits |
|---|---|---|
| | Research Methodology | 3 |

**<u>Unit-I</u>: Research Orientation** **15 lectures**

**Basic concepts of research:** Meaning and importance of Research – Types of Research – Selection and formulation of Research Problem – Research Design Types and methods of research: Classification of research, basic and applied research – similarities and differences, Interdisciplinary research, case study, field study, survey of research fields, and methods of research as applied to basic and applied sciences – a few examples.

**Data Collection and Presentation:** Objectives and classification of data, data organization, presentation and interpretation – general concepts and methods, use of computers and related software for data collection, analysis and interpretation.

**Ethics in Research:** General ideas on presentation of scientific research, dissemination of research findings different methods such as publishing reports, patents and patent rules, presentation of work in conferences, ethics and norms to be followed in presentation of research findings, plagiarism and its consequences, how to avoid plagiarism in scientific research – a few case study.

**Scientific Report Writing:** Basic motivation for writing scientific report, content of a research report – a few case study, methods of preparing research reports, use of computers in preparing reports, quantification of quality of research disseminated through journals or patents.

**<u>Unit-II:</u> Data Analysis for Physical Sciences** **15 lectures**

Population and Sample, Data distributions Probability, Probability Distribution, Distribution of Real Data, The normal distribution, The normal distribution, From area under a normal curve to an interval, Distribution of sample means, The central limit theorem, The t distribution, The log- normal distribution, Assessing the normality of data, Population mean and continuous distributions, Population mean and expectation value, The binomial distribution The Poisson distribution, Experimental Error, Measurement, error and uncertainty, The process of measurement, True value and error, Precision and accuracy, Random and systematic errors, Random errors, Uncertainty in measurement.

Internal tests will be of solving problems using Excel.

**<u>Unit-III:</u> Numerical Techniques/Methods** **15 lectures**

Curve fitting methods – Modeling of Data, Maximum Likelihood Estimator; Pearson chi- 96 square; Least Squares method – both without and with errors in dependent variable; Parameter estimations and errors;

Fitting a linear and non-linear curve, Linear interpolation, difference schemes, Newton's forward and backward interpolation formula, Lagrange's interpolation formula.

Random Numbers – Uniform and other random deviates, Generation of Random Numbers, Random walk problem in 1, 2, 3 dimensions, Simulation – Introduction, Monte Carlo Methods – Introduction; Few examples: Coin toss and dice throws, Radioactive Decay, Two-Level Spin System, Ising Model, Scattering - Toy model;

**References:**


1. Numerical Recipes 3rd Edition: The Art of Scientific Computing, William H. Press, Saul A. Teukolsky, William T. Vetterling , Brian P. Flannery (3rd Ed., Cambridge University Press, 2007)
2. Numerical Analysis, Richard L. Burden, J. Douglas Faires, Annette M. Burden (10th Ed., Cengage Learning, 2016)
3. Data Reduction and Error Analysis for the Physical, Philip Bevington and D. Keith Robinson (3rd Ed., McGraw Hill Education, 2003)
4. Monte Carlo Simulation in Statistical Physics: An Introduction, Binder, Kurt, Heermann, Dieter (5th Ed., Springer, 2010)
5. research methodology: methods and techniques by C R Kothari, 4th edition, new age international publication.
6. How to write and Publish a Scientific Paper, Robert A. Day and Barbara Gastel (Cambridge University Press).
7. How to Research, Loraine Blaxter, Christina Hughes and Malcum Tight (Open University Press).
8. The Craft of Scientific Writing, Michael Alley, (Springer).
9. A Student's Guide to Methodology, Peter Clough and Cathy Nutbrown (Sage Publications).
10. Numerical Analysis, Richard L. Burden, J. Douglas Faires, Annette M. Burden (10th Ed., Cengage Learning, 2016)
11. Data Reduction and Error Analysis for the Physical, Philip Bevington and D. Keith Robinson (3rd Ed., McGraw Hill Education, 2003)
12. Monte Carlo Simulation in Statistical Physics: An Introduction, Binder, Kurt, Heermann, Dieter (5th Ed., Springer, 2010)
13. Data Analysis for Physical Sciences (Featuring Excel®) Les Kirkup, 2nd Edition, Cambridge University Press (2012), Chapters 1-6 and 9
14. Statistical Methods in Practice for scientists ad Technologists, Richard Boddy and Gordon Smith, John Wiley & Sons (2009)

**<u>Semester –I</u>**

| Course Code | Title | Credits |
|---|---|---|
| | Elective Paper – I: Advanced Electronics | 3 |

**<u>Unit-I:</u> Microprocessors and Microcontrollers** **15 lectures**

Microprocessors: Counters and Time Delays, Stack and Sub-routines, 8085 Interrupts.
Introduction to Microcontrollers: Introduction, Microcontrollers and Microprocessors, History of Microcontrollers and Microprocessors, Embedded versus External Memory Devices, 8–bit and 16–bit Microcontrollers, CISC and RISC Processors, Harvard and Von Neumann Architectures, Commercial Microcontroller Devices.
8051 Microcontrollers: Introduction, MCS–51 Architecture, Registers in MCS-51, 8051 Pin Description, Connections,8051 Parallel I/O Ports and Memory Organization.
8051 Instruction set and Programming: MCS-51 Addressing Modes and Instruction set. 8051 Instructions and Simple programs using Stack Pointer.

**<u>Unit-II:</u> Analog and Data Acquisition Systems** **15 lectures**

Power Supplies: Linear Power supply, Switch Mode Power supply, Uninterrupted Power Supply, Step up and Step down Switching Voltage Regulators.
Inverters: Principle of voltage driven inversion, Principle of current driven inversion, sine wave inverter, Square wave inverter.
Signal Conditioning: Operational Amplifier, Instrumentation Amplifier using IC, Precision Rectifier, Voltage to Current Converter, Current to Voltage Converter, Op-Amp Based Butterworth Higher Order Active Filters and Multiple Feedback Filters, Voltage Controlled Oscillator , Analog Multiplexer, Sample and Hold circuits, Analog to Digital Converters, Digital to Analog Converters.

**<u>Unit-III:</u> Data Transmissions, Instrumentations Circuits& Designs** **15 lectures**

Data Transmission Systems: Analog and Digital Transmissions, Pulse Amplitude Modulation, Pulse Width Modulation, Time Division Multiplexing, Pulse Modulation, Digital Modulation, Pulse Code Format, Modems.
Optical Fiber: Introduction to optical fibers, wave propagation and total internal reflection in optical fiber, structure of optical fiber, Types of optical fiber, numerical aperture, acceptance angle, single and multimode optical fibers, optical fiber materials and fabrication, attenuation, dispersion, splicing and fiber connectors, fiber optic communication system, fiber sensor, optical sources and optical detectors for optical fiber.

**<u>Reference Books:</u>**

1. R. S. Gaonkar, *Microprocessor Architecture, Programming and Applications with the 8085*, 4th Edition. Penram International.
2. Ajay V. Deshmukh, *Microcontrollers (Theory and Applications*), TMH.
3. Dr. Rajiv Kapadia, *The 8051 Microcontroller and Embedded Systems*, Jaico Publishing House.
4. M.A. Mazidi, J.G. Mazidiand R.D. Mckinlay**,** *The 8051 Microcontroller & Embedded Systems*.

5. K.J. Ayala, *The 8051 Microcontroller*, Penram International.
6. Myke Predko, *Programming & customizing the 8051 Microcontroller*, TMH.
7. Alok Jain, *Power Electronics and its applications*, 2nd Edition, Penram International India.
8. R. A. Gayakwad, *Op-Amps and Linear Integrated Circuits*, 3rd Edition Prentice Hall India.
9. Robert F. Coughlin and Frederic F. Driscoll, *Operational Amplifiers and Linear Integrated Circuits*, 6th Edition, Pearson Education Asia.
10. Keiser, G. *Optical Fiber Communications*, Mcgraw Hill, Int. Student Ed.
11. Kennedy and Davis, *Electronic Communication Systems*, 4th. Ed (Tata- McGraw. Hill, 2004.
12. H.S. Kalsi, *Electronic Instrumentation*, Tata-McGraw. Hill, 1999.

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Lab course - 1 | 4 |

**Group A:**

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Michelson Interferometer. | *Advanced Practical Physics* -Worsnop and Flint. |
| 2 | Analysis of sodium spectrum. | a. *Atomic spectra*- H.E. White.<br>b. *Experiments in modern physics* – Mellissinos. |
| 3 | h/e by vacuum photocell. | a. *Advanced Practical Physics* -Worsnop and Flint.<br>b. *Experiments in modern physics* – Mellissinos. |
| 4 | Study of He-Ne laser- Measurement of divergence and wavelength. | a. *A course of experiments with Laser* – Sirohi.<br>b. *Elementary experiments with Laser* - G. White. |
| 5 | Susceptibility measurement by Quincke's method /Guoy's balance method. | *Advanced Practical Physics* -Worsnop and Flint. |
| 6 | Magneto resistance of Bi specimen. | *Semiconductor measurements* by Runyan. |
| 7 | Microwave oscillator characteristics. | *Physics of Semiconductor Devices* by S.M.Sze. |

**Group B:**

| Sr. No | **Experiment** | **References** |
|---|---|---|
| 1. | Regulated dual power supply using IC LM317 & 1C LM 337 voltage regulator ICs. | a. *Operational amplifiers and linear Integrated circuits* - Coughlin & Driscoll.<br>b. *Practical analysis of electronic circuits through experimentation* – L. Macdonald. |
| 2. | Constant current supply using IC 741 and LM317. | *Integrated Circuits* - K. R. Botkar. |
| 3. | Diac - Triac phase control circuit. | a. *Solid state devices*- W.D. Cooper.<br>b. *Electronic text lab manual* - P.B. Zbar. |
| 4. | Study of 8 bit DAC. | a. *Op-amps and linear integrated circuit technology* — R. Gayakwad.<br>b. *Digital principles and applications* by Malvino and Leach. |
| 5. | 16 Channel digital multiplexer. | *a. Digital principles and applications by Malvino and Leach.*<br>*b. Digital circuit practice by RP Jain.* |
| 6 | Pulse width modulation for speed control of dc toy motor. | *Electronic Instrumentation* - H. S. Kalsi. |

Minimum 3 experiments each from Group A and Group B to be performed and reported in the journal.

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Elective Lab course - 1 | 1 |

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Study of 8085 microprocessor Kit and execution of simple Programs. | a. *Microprocessor Architecture, Programming and Applications with the 8085* - R. S. Gaonkar.<br>b. *Microprocessor fundamentals- Schaum Series*- Tokheim.<br>c. 8085 Kit User manual. |
| 2 | 8051 assembly language programming | a. M.A. Mazidi, J.G. Mazidi and R.D. Mckinlay, *The 8051 Microcontroller & Embedded Systems*, Second Edition, Pearson.<br>b. Ajay V. Deshmukh, *Microcontrollers*, Tata-Mcgraw Hill Publication. |
| 3 | Study of 8085 interrupts (Vector Interrupt 7.5). | *Microprocessor Architecture, Programming and Applications with the 8085 - R. S. Gaonkar* |
| 4 | Waveform generation using 8085. | a. *Microprocessor Architecture, Programming and Applications with the 8085* - R. S. Gaonkar.<br>b. *Microprocessor fundamentals- Schaum Series*- Tokheim. |
| 5 | Active filter circuits (second order). | a. *Op-amps and linear integrated circuit technology*- R. Gayakwad .<br>b. *Operational amplifiers and linear integrated circuits* - Coughlin &. Driscoll. |
| 6 | Study of sample and hold circuit. | *Integrated Circuits* - K. R. Botkar. |
| 7 | Instrumentation amplifier and its applications. | a. *Operational amplifiers and linear integrated circuits* -Coughlin &. Driscoll.<br>b. *Integrated Circuits* - K. R. Botkar. |
| 8 | Analog to Digital Converter using IC | a. *Op-amps and linear integrated circuit technology*- R. Gayakwad .<br>b. M.A. Mazidi, J.G. Mazidi and R.D. Mckinlay, *The 8051 Microcontroller & Embedded Systems*, Second Edition, Pearson. |
| 9 | SID& SOD using 8085. | a. *Microprocessor Architecture, Programming and Applications with the 8085* - R. S. Gaonkar.<br>b. *Microprocessor fundamentals- Schaum Series*- Tokheim.<br>c. 8085 Kit User manual. |

Minimum 5 experiments to be performed and reported in the journal.

**Semester –I**

| Course Code | Title | Credits |
|---|---|---|
| | Research Methodology | 1 |

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Scientific writing (report, research proposal) | Research methodology: methods and techniques by C R Kothari, 4th edition, new age international publication. |
| 2 | Poster making | |
| 3 | Implementing random walk problem in 1- and 2- dimensions. | Data Analysis for Physical Sciences (Featuring Excel®) Les Kirkup, 2nd Edition, Cambridge University Press (2012), Chapters 1-6 and 9 |
| 4 | Random number generation and its application. | |
| 5 | Modeling of data – chi square fitting and least square fit for linear and non-linear equations (using Excel). | Monte Carlo Simulation in Statistical Physics: An Introduction, Binder, Kurt, Heermann, Dieter (5th Ed., Springer, 2010) |

Minimum 3 experiments to be performed and reported in the journal.

**Note:**

Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Students who do not have certified journals, will not be allowed to appear for the practical examinations.

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Electrodynamics | 4 |

**Unit-I: Tensor Representation in Electromagnetic Theory** **15 lectures**

Maxwell's equations, The Pointing vector, The Maxwellian stress tensor, Lorentz Transformations, Four Vectors and Four Tensors, The field equations and the field tensor, Maxwell equations in covariant notation.

**Unit-II: Electromagnetic Waves and Wave Guides** **15 lectures**

Electromagnetic waves in vacuum, Polarization of plane waves. Electromagnetic waves in matter, frequency dependence of conductivity, frequency dependence of polarizability, frequency dependence of refractive index. Wave guides, boundary conditions, classification of fields in wave guides, phase velocity and group velocity, resonant cavities.

**Unit-III: Gauge Transformation & Electric Dipole Radiations** **15 lectures**

Moving charges in vacuum, gauge transformation, The time dependent Green function, The Lienard-Wiechert potentials, Leinard-Wiechert fields, application to fields-radiation from a charged particle, Antennas, Radiation by multipole moments, Electric dipole radiation, Complete fields of a time dependent electric dipole, Magnetic dipole radiation.

**Unit-IV: Relativistic Electrodynamics** **15 lectures**

Relativistic covariant Lagrangian formalism: Covariant Lagrangian formalism for relativistic point charges. The energy-momentum tensor, Conservation laws.

**Main Reference:**


1. W. Greiner, *Classical Electrodynamics*, (Springer- Verlag, 2000) (WG).
2. M.A. Heald and J.B. Marion, *Classical Electromagnetic Radiation*, 3rd edition (Saunders, 1983) (HM).


**Additional references:**


1. J.D. Jackson, *Classical Electrodynamics*, 4Th edition, (John Wiley & sons) 2005 (JDJ).
2. W.K.H. Panofsky and M. Phillips, *Classical Electricity and Magnetism*, 2nd edition, (Addison - Wesley) 1962.
3. D.J. Griffiths, *Introduction to Electrodynamics*, 2nd Ed., Prentice Hall, India, 1989.
4. J.R. Reitz, E.J. Milford and R.W. Christy, *Foundation of Electromagnetic Theory*, 4th ed., Addison -Wesley, 1993.

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Quantum Mechanics-II | 4 |

**Unit-I: Perturbation Theory** **15 lectures**

Time independent perturbation theory: First order and second order corrections to the energy eigenvalues and eigenfunctions. Degenerate perturbation Theory: first order correction to energy.

Time dependent perturbation theory: Harmonic perturbation, Fermi's Golden Rule, sudden and adiabatic approximations, applications.

**Unit-II: Approximation Methods** **15 lectures**

Variation Method: Basic principle, applications to simple potential problems, He-atom.

WKB Approximation: WKB approximation, turning points, connection formulas, Quantization conditions, applications.

**Unit-III: Scattering Theory** **15 lectures**

Laboratory and centre of mass frames, differential and total scattering cross-sections, scattering amplitude, Partial wave analysis and phase shifts, optical theorem, S-wave scattering from finite spherical attractive and repulsive potential wells, Born approximation.

**Unit-IV: Relativistic Quantum Mechanics and Dirac Equation** **15 lectures**

Identical Particles: Symmetric and antisymmetric wave functions, Bosons and Fermions, Pauli Exclusion Principle, slater determinant.

Relativistic Quantum Mechanics.

The Klein Gordon and Dirac equations. Dirac matrices, spinors, positive and negative energy solutions physical interpretation. Nonrelativistic limit of the Dirac equation.

**Main references:**

1. Richard Liboff, *Introductory Quantum Mechanics*, 4$^{th}$ edition, Pearson.
2. D. J. Griffiths, *Introduction to Quantum Mechanics* 4$^{th}$ edition.
3. A. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications*, 5$^{th}$ edition.
4. N. Zettili, *Quantum Mechanics: Concepts and Applications*, 2$^{nd}$ edition, Wiley.
5. 5. J. Bjorken and S. Drell, *Relativistic Quantum Mechanics*, McGraw-Hill (1965).

**Additional References:**

1. W. Greiner, *Quantum Mechanics: An introduction*, Springer, 2004.
2. R. Shankar, *Principles of Quantum Mechanics*, Springer, 1994.
3. P.M. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics*, Tata McGraw Hill (1977).
4. J.J. Sakurai, *Modern Quantum Mechanics*, Addison-Wessley (1994).

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Classical Mechanics-II | 2 |

**Unit-I: Central Force Problem** **15 lectures**

Conservation theorems and symmetry properties, Energy Function and the conservation of energy. The Two-Body Central Force Problem**:** Reduction to the equivalent one body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The virial theorem, The differential equation for the orbit and integrable power-law potentials, The Kepler problem: Inverse square law of force, The motion in time in the Kepler problem, Scattering in a central force field, Transformation of the scattering problem to laboratory coordinates.

**Unit-II: Small Oscillations** **15 lectures**

Small Oscillations: Formulation of the problem, the eigenvalue equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Forced and damped oscillations, Resonance and beats.

Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle.

**Main Reference:** H. Goldstein, Poole and Safko, *Classical Mechanics*, 3rd Edition, Narosa Publication (2001).

**Additional References:**

5. N. C. Rana and P. S. Joag, *Classical Mechanics*, Tata McGraw Hill Publication.
6. S. N. Biswas, *Classical Mechanics,* Allied Publishers (Calcutta).
7. V. B. Bhatia, *Classical Mechanics*, Narosa Publishing (1997).
8. Landau and Lifshitz, Butterworth, *Mechanics*, Heinemann.
9. R. V. Kamat, *The Action Principle in Physics*, New Age Intnl. (1995).
10. Vol I and II, E. A. Deslougue, *Classical Mechanics*, John Wiley (1982).
11. *Theory and Problems of Lagrangian Dynamics, Schaum Series,* McGraw (1967).
12. K. C. Gupta, *Classical Mechanics of Particles and Rigid Bodies*, Wiley Eastern 2001).

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Elective Paper – II: Microcontrollers and Interfacing | 3 |

**Unit-I: 8051 microcontroller (Advanced)** **15 lectures**

Programming 8051 Timers, Counter Programming.

Basics of Serial Communication, 8051 Connection to RS232, 8051 Serial Port Programming in assembly. 8051 Interrupts, Programming Timer Interrupts,

Programming External hardware Interrupts, Programming the Serial Communication Interrupt, Interrupt Priority in 8051/52.

**Unit-II: PIC 16F8XX Flash Microcontrollers** **15 lectures**

Introduction, Pin Diagram, STATUS Register, Power Control Register (PCON), OPTION_REG Register, Program memory, Data memory, I/O Ports, Instruction set.

**Unit-III: Interfacing microcontroller/PIC microcontroller and Industrial Applications of microcontrollers** **15 lectures**

Capture/Compare/PWM (CCP) Modules in PIC 16F877, Analog-to-Digital Converter.

Light Emitting Diodes (LEDs); Push Buttons, Relays and Latch Connections; Keyboard Interfacing; Interfacing 7-Segment Displays; LCD Interfacing; ADC and DAC Interfacing with 89C51 Microcontrollers.

Introduction and Measurement Applications (For DC motor interfacing and PWM refer Sec 17.3 of MMM)

**References:**


1. Ajay V. Deshmukh, *Microcontrollers*, Tata-Mcgraw Hill Publication
2. M.A. Mazidi, J.G. Mazidi and R.D. Mckinlay, *The 8051 Microcontroller & Embedded Systems*, Second Edition, Pearson.


**Additional Reference books:**


1. Dr. Rajiv Kapadia, *The 8051 Microcontroller & Embedded Systems*, (Jaico Pub.House)
2. K.J.Ayala, *8051 Micro-controller*, Penram International.
3. John B. Peatman, *Design with PIC microcontrollers*, Pearson Education Asia.
4. Myke Predko, *Programming & customizing the 8051 microcontroller*, TMH.

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Lab course - 2 | 4 |

**Group A:**

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Measurement of Refractive Index of Liquids using Laser. | Sirohi-*A course of experiments with He-Ne Laser*; Wiley Eastern Ltd. |
| 2 | Determination of Young's modulus of metal rod by interference method. | *Advance practical physics* - Worsnop and Flint. (page 338) |
| 3 | Simulation Experiment (CM) | *Steven Koonin* - Computational Physics |
| 4 | Ultrasonic Interferometry-Velocity measurements in different Fluids. | *Medical Electronics*- Khandpur. |
| 5 | Absorption spectrum of specific Liquids. | *Advanced Practical Physics* -Worsnop and Flint. |
| 6 | Zeeman Effect using Fabry-Perot etalon /Lummer — Gehrecke plate. | a. *Advance practical physics* - Worsnop and Flint.<br>b. *Experiments in modern physics* – Mellissinos. |
| 7 | Faraday Effect-Magneto Optic Effect:<br>a) To Calibrate Electromagnet.<br>b) To determine Verdet's constant for KCI & KI solutions. | a. *Manual of experimental physics*: E.V. Smith.<br>b. *Experimental physics for students*: Whittle & Yarwood. |

**Group B:**

| Sr. No | **Experiment** | **References** |
|---|---|---|
| 1. | Adder-subtractor circuits using ICs. | a. *Digital Principles and applications*-Malvino and Leach.<br>b. *Digital circuit practice*-R.P.Jain. |
| 2. | Study of Presettable counters-74190 and 74193. | a. *Digital circuit practice*-Jain & Anand.<br>b. *Digital Principles and applications*-Malvino and Leach.<br>c. *Experiments in digital practice*-Jain & Anand. |
| 3. | TTL characteristics of Totempole, Open collector and tristate devices. | a. *Digital circuit practice*-Jain & Anand.<br>b. *Digital Principles and applications*-Malvino and Leach. |
| 4. | Study of 4 digit multiplex display system. | *Digital Electronics* - Roger Tokheim. |
| 5. | Delayed linear sweep using 1C 555. | *Electronic Principles* - A. P. Malvino. |
| 6 | Ambient Light control power Switch. | a. *Electronic Instrumentation* H. S. Kalsi. Helfrick & Cooper, PHI. |

Minimum 3 experiments each from Group A and Group B to be performed and reported in the journal.

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | Elective Lab course - 2 | 1 |

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Study of 8051 I/O ports. | a. 8031/8051 Manual provided by the manufacturers.<br>b. Ajay V. Deshmukh, *Microcontrollers*, Tata-Mcgraw Hill Publication.<br>c. M.A. Mazidi, J.G. Mazidi and R.D. Mckinlay, *The 8051 Microcontroller & Embedded Systems*, Second Edition, Pearson. |
| 2 | Study of 8051 internal timer and counter | |
| 3 | Study of 8051 external interrupts | |
| 4 | Interfacing DAC with 8051 | |
| 5 | Interfacing ADC with 8051 | |
| 6 | Interfacing LEDs with PIC microcontroller | |
| 7 | Interfacing Push buttons with PIC microcontroller | |
| 8 | Interfacing Relay with PIC microcontroller | |
| 9 | Interfacing 7-segments with PIC microcontroller | |
| 10 | Interfacing Opto-coupler with PIC microcontroller | |
| 11 | Interfacing Buzzer with PIC microcontroller | |

Minimum 5 experiments to be performed and reported in the journal.

**Note:**

Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Students who do not have certified journals, will not be allowed to appear for the practical examinations.

## Semester –II

| Course Code | Title | Credits |
|---|---|---|
| | On Job Training | 4 |

**Semester –III**

| Course Code | Title | Credits |
|---|---|---|
| | Statistical Mechanics | 4 |

**Unit – I: The Statistical Basis of Thermodynamics** **15 lectures**

The macroscopic and the microscopic states, contact between statistics and thermodynamics, the classical ideal gas, The entropy of mixing and the Gibbs paradox, the enumeration of the microstates.

Elements of Ensemble Theory - Phase space of a classical system, Liouville's theorem and its consequences.

The micro-canonical ensemble – Examples. Quantum states and the phase space.

**Unit – II: The Canonical Ensemble** **15 lectures**

Equilibrium between a system and a heat reservoir, a system in the canonical ensemble, physical significance of the various statistical quantities in the canonical ensemble, expressions of the partition function, the classical systems, energy fluctuations in the canonical ensemble, correspondence with the micro-canonical ensemble, the equipartition theorem and the virial theorem, system of harmonic oscillators, statistics of paramagnetism, thermodynamics of magnetic systems.

**Unit – III: The Grand Canonical Ensemble** **15 lectures**

Equilibrium between a system and a particle-energy reservoir, a system in the grand canonical ensemble, physical significance of the various statistical quantities, Examples, Density and energy fluctuations in the grand canonical ensemble, correspondence with other ensembles.

**Unit – IV: Formulation of Quantum Statistics** **15 lectures**

Quantum-mechanical ensemble theory: the density matrix, Statistics of the various ensembles, Examples, systems composed of indistinguishable particles, the density matrix and the partition function of a system of free particles.

**Note:** 50% of time allotted for lectures to be spent in solving problems.

**Main Reference**:

R. K. Pathria & Paul D. Beale, *Statistical Mechanics*, (Third Edition), Elsevier 2011 – Chap. 1 to 5.

**Additional References**:

1. Greiner, Neise and Stocker, *Thermodynamics and Statistical Mechanics*, Springer 1995.
2. Kerson Huang, Taylor and Francis, *Introduction to Statistical Physics*, 2001.
3. F. Reif, *Thermal and Statistical Physics*.
4. D. Amit and Walecka, *Statistical Physics*.
5. Kerson Huang, *Statistical Mechanics.*
6. J.K. Bhattacharjee, *Statistical Mechanics*.
7. J.K. Bhattacharjee, *Non-equilibrium Statistical Mechanics*.
8. Richard Feynman, *Statistical Mechanics*.
9. Landau and Lifshitz, *Statistical Mechanics*.
10. H.B. Callen, *Thermodynamics*.

**Semester –III**

| Course Code | Title | Credits |
|---|---|---|
| | Nuclear Physics | 4 |

**Unit-I: Nuclear Properties and Nuclear Decay** **15 lectures**

Nuclear Properties (Review), Measurement of Nuclear size and estimation of R0, Q-value equation, Separation energies, Deuteron system and its characteristic, Estimate the depth and size of (assume) square well potential, introduction to Tensor force, nucleon-nucleon scattering-qualitative discussion on results.

Review of alpha decay, Introduction to Beta decay and its energetic, Fermi theory of beta decay, Kurie plot, Comparative half-lives, Fermi and Gamow-Teller transitions. Parity violation in beta-decay.

Gamma decay: Multipole radiation, Selection rules for gamma ray transitions, Gamma ray interaction with matter, and Charge-particle interaction with matter.

**Unit-II: Nuclear Models and Nuclear Reactions** **15 lectures**

Nuclear Models: Shell Model (extreme single particle): Introduction, Assumptions, Evidences, Spin-orbit interactions, Predictions including Schmidt lines, limitations, Collective model - Introduction to Nilsson Model.

Introduction to Nuclear Reactions, Conservation Laws, kinematics of reactions, Q-value, energy release in fusion and fission reaction, reaction rate, reaction cross section, Concept of Direct and compound nuclear reaction.

**Unit-III: Experimental Techniques in Nuclear Physics** **15 lectures**

Interaction of radiation (heavy charged particles, electrons, gamma rays and neutron) with matter, Radiation detectors, General characteristics of detectors: efficiency, resolution.

Gas detectors: Basic processes, ionization and charge multiplication. Ionization chamber, proportional counter and Geiger Muller counter.

Semiconductor detectors: Silicon detectors, Germanium (HPGe) detectors,

Scintillation detectors: Inorganic and organic scintillators, photomultipliers, photodiodes

Accelerators: Cockroft Walten Generator, Van de Graaf Generator, Sloan and Lawrence type Linear Accelerator, Proton Linear Accelerator, Cyclotron and Synchrotron.

**Unit-IV: Elementary Particle Physics** **15 lectures**

Introduction to the elementary particle Physics, Relativistic kinematics, Various Interactions, Parity, Charge Conjugation and Time Reversal, Classification: spin and parity determination of pions and strange particles. Gell-Mann Nishijima scheme. the Quark Model: Properties of quarks and their classification. Eightfold way, Mesons and Baryons, Elementary ideas of SU(2) and SU(3) symmetry groups and hadron classification. Introduction to the standard model. Revision of the four forces, Introduction to Quantum Eletrodynamics, Introduction to Quantum Chromodynamics.

**Main References:**

1. Kenneth Krane, *Introductory Nuclear Physics*, Wiley India Pvt. Ltd.
2. Robert Eisberg and Robert Resnick, *Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles*, Wiley (2006).
3. David Griffith, *Introduction to Elementary Particles*, John Wiley and sons.
4. Radiation Detection and Measurement, G.F. Knoll, 4th edition (John Wiley & Sons, New York, 2010)
5. Techniques for Nuclear and Particle Physics Experiments, W.R. Leo, 2nd Edition. Springer International Student
6. Physics & Engineering of Radiation Detection, S. N. Ahmed (Academic Press 2007)

**Other References:**

7. H. A. Enge, *Introduction to Nuclear Physics*, Eddison Wesley.
8. E. Segre, W. A. Benjamin, *Nuclei and Particles*.
9. B. L. Cohen, *Concepts of Nuclear Physics*.
10. H. Fraunfelder and E. Henley, *Subatomic Particles*, Prentice Hall.
11. H. S. Hans, *Nuclear Physics: Experimental and Theoretical*, New Age International.
12. A. Das & T. Ferbel, *Introduction to Nuclear and Particle Physics*, World Scientific.
13. D. H. Perkins, *Introduction to high energy physics*, Addison Wesley.
14. W. E. Burcham and M. Jones, *Nuclear and Particle Physics*, Addison Wesley.
15. S. M. Wong, *Introductory Nuclear Physics*, Prentice Hall.
16. S. B. Patel, *Nuclear Physics: An Introduction*, New Age International.
17. S. N. Ghoshal, *Nuclear Physics*.
18. Roy and Nigam, *Nuclear Physics*.

## Semester –III

| Course Code | Title | Credits |
|---|---|---|
| | Elective Paper-III: Advanced Microprocessor, Embedded system and RTOS | 3 |

**Unit-I: 8086 microprocessor** **15 lectures**

Register organization of 8086, Architecture, Signal Descriptions of 8086, Physical Memory Organization, General Bus operation, I/O Addressing Capability, Special Processor Activities, Minimum mode 8086 system and timings, Maximum mode of 8086 system and timings.

8086 Instruction set and assembler directives:

Machine Language Instructions Formats, Addressing modes of 8086, Instruction set of 8086.

The Art of Assembly Language Programming with 8086:

A few machine level programs, Machine coding the programs, Programming with an assembler (only using Debug), Assembly language example programs.

Special architectural features and related programming:

Introduction to Stack, Stack structure of 8086, interrupts and Interrupt Service Routines, Interrupt cycle of 8086, Non-maskable interrupt, Maskable interrupt (INTR).

(Note: Also refer Intel's 8086 Data Sheet)

**Unit-II: ARM 7** **15 lectures**

The ARM Architecture: The Acorn RISC Machine, Architectural inheritance, The ARM Programmer's model, ARM development tools.

ARM Organization and Implementation: 3 – stage Pipeline ARM organization, ARM instruction execution.

ARM Assembly language Programming: Data processing instructions, Data transfer instructions, Control flow instructions, writing simple assembly language programs.

The ARM Instruction Set: Introduction, Exceptions, Condition execution, Branch and Branch with Link (B, BL), Branch, Branch with Link and exchange (BX,BLX), Software Interrupt (SWI), Data processing instructions , Multiply instructions, Count leading zeros (CLZ), Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Swap memory and register instructions (SWP), Status register to general register transfer instructions, General register to Status register transfer instructions

The Thumb Instruction Set: the Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications, Example and exercises.

**Unit-III: Embedded System and RTOS** **15 lectures**

A Typical Embedded system: Core of the embedded system.

Characteristics and quality Attributed of Embedded Systems: Characteristics of an Embedded System, Quality Attributes of Embedded Systems.

Embedded Systems-Application and Domain–Specific: Washing Machine, Automatic-Domain, Specific examples of embedded system.

Design Process and design Examples: Automatic Chocolate Vending machine (ACVM), Smart Card, Digital Camera, Mobile Phone, A Set of Robots

Real –Time Operating System based Embedded System Design

Operating system Basics, Types of Operating Systems, Tasks, Process and Threads, Multi-processing and Multitasking, Task Scheduling, Threads, Processes and Scheduling: Putting them altogether, task Communication, task Synchronizations, Device Drivers, How to choose an RTOS.

**References:**


1. K. Ray and K. M Bhurchandi, *Advanced Microprocessors and Peripherals,* Second Edition Tata McGraw–Hill Publishing Company Ltd.
2. Steve Furber, *ARM System-on-Chip Architecture*, Second Edition, Pearson.
3. K. V. Shibu, *Introduction to embedded systems*, Sixth Reprint 2012, Tata McGraw Hill.
4. Raj Kamal, "*Embedded Systems" Architecture, Programming and Design*, Second Edition, The McGraw-Hill Companies.

## Semester –III

| Course Code | Title | Credits |
|---|---|---|
| | Lab course - 3 | 4 |

**Group A:**

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | DC Hall effect. | a. *Manual of experimental physics* - E.V. Smith.<br>b. *Semiconductor Measurements* – Runyan.<br>c. *Semiconductors and solid state physics* – Mackelvy.<br>d. *Handbook of semiconductors* – Hunter. |
| 2 | Simulation Experiment (SM) | *a.* Kurt Binder, Dieter Heermann - *Monte Carlo simulation in statistical physics*<br>*b.* *Introduction to Modern Statistical Mechanics* - David Chandler<br>*c.* *Konstantinos Anagnostopoulos - Computational Physics* |
| 3 | Characteristics of a Geiger Muller counter and measurement of dead time. | a. *Experiments in modern physics*: Mellissions.<br>b. *Manual of experimental physics* --EV-Smith.<br>*Experimental physics for students* - Whittle & Yarwood. |
| 4 | Determination of particle size of lycopodium particles by laser diffraction method. | a. *A course of experiments with Laser* -Sirohi.<br>b. *Elementary experiments with Laser*-G.White. |
| 5 | Coupled Oscillations. | HBCSE Selection camp 2007 Manual. |
| 6 | Measurement of dielectric constant, Curie temperature and verification of Curie— Weiss law for ferroelectric material. | a. *Electronic instrumentation & measurement*,W. D. Cooper.<br>b. *Introduction to solid state physics* - C. Kittel.<br>c. *Solid state physics* — A. J. Dekkar. |

**Group B:**

| Sr. No | **Experiment** | **References** |
|---|---|---|
| 1. | Regulated power supply using LM 317 voltage regulator IC. | a. *Operational amplifiers and linear Integrated circuits* - Coughlin & Driscoll.<br>b. *Practical analysis of electronic circuits through experimentation* – L. Macdonald. |
| 2. | Linear Voltage Differential Transformer. | *Electronic Instrumentation* - W.D. Cooper. |

| | | |
|---|---|---|
| 3. | Shift registers. | a. *Experiments in digital principles*-D.P. Leach.<br>b. *Digital principles and applications* - Malvino and Leach. |
| 4. | Switching Voltage Regulator. | *Integrated Circuits* - K. R. Botkar. |
| 5. | Study of elementary digital Voltmeter. | *Digital Electronics* by Roger Tokheim (5 Ed, page 371). |
| 6 | Interfacing TTL with buzzers, relays, motors and solenoids. | *Digital Electronics* by Roger Tokheim. |

Minimum 3 experiments each from Group A and Group B to be performed and reported in the journal.

<u>**Semester –III**</u>

| Course Code | Title | Credits |
|---|---|---|
| | Elective Lab course - 3 | 1 |

| Sr. No | Experiment | Reference Books |
|---|---|---|
| 1 | 8086 assembly language programming | K. Ray and K. M Bhurchandi, *Advanced Microprocessors and Peripherals*, Second Edition Tata McGraw–Hill Publishing Company Ltd. |
| 2 | 8086 interfacing-1 | |
| 3 | 8086 interfacing-2 | |
| 4 | Simple data manipulation programs using ARM7 | Steve Furber, *ARM System-on-Chip Architecture*, Second Edition, Pearson |
| 5 | Study of IN and OUT port of ARM7 by Interfacing | |
| 6 | Interfacing DAC/ADC using I2C Protocols | |
| 7 | Study of Timer of ARM 7 | |
| 8 | Embedded system based Experiment(embedded C) | |

Minimum 5 experiments to be performed and reported in the journal.

**Note:**

Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Students who do not have certified journals, will not be allowed to appear for the practical examinations.

## Semester –III

| Course Code | Title | Credits |
|---|---|---|
| | Research Project - 1 | 6 |

## Semester –IV

| Course Code | Title | Credits |
|---|---|---|
| | Atomic and Molecular Physics | 4 |

**Unit-I: Spectroscopic studies of hyperfine structure** **15 lectures**

Review of one-electron eigenfunctions and energy levels of bound states, Probability density, Virial theorem. Fine structure of hydrogenic atoms, Lamb shift. Hyperfine structure and isotope shift.

Linear and quadratic Stark effect in spherical polar coordinates. Zeeman Effect in strong and weak fields, Paschen-Back effect.

Schrodinger equation for two electron atoms: Identical particles, The Exclusion Principle. Exchange forces and the helium atom, independent particle model, ground and excited states of two electron atoms.

**Unit-II: Electron Coupling (LS & JJ)** **15 lectures**

The central field, Thomas-Fermi potential, the gross structure of alkalis The Hartree theory, ground state of multi-electron atoms and the periodic table, The L-S coupling approximation, allowed terms in LS coupling, fine structure in LS coupling, relative intensities in LS coupling, j-j coupling approximation and other types of coupling.

**III: Interaction of atoms with radiation** **15 lectures**

Interaction of one electron atoms with electromagnetic radiation: Electromagnetic radiation and its interaction with charged particles, absorption and emission transition rates, dipole approximation. Einstein coefficients, selection rules. Line intensities and life times of excited state, line shapes and line widths. X-ray spectra.

**Unit-IV: Rotational and Vibrational Spectra** **15 lectures**

Born-Oppenheimer approximation - rotational, vibrational and electronic energy levels of diatomic molecules, Linear combination of atomic orbitals (LCAO)and Valence bond (VB) approximations, comparison of valence bond and molecular orbital theories.

Rotation of molecules: rotational energy levels of rigid and non-rigid diatomic molecules, classification of molecules, linear, spherical, symmetric and asymmetric tops.

Vibration of molecules: vibrational energy levels of diatomic molecules, simple harmonic and anharmonic oscillators, diatomic vibrating rotator and vibrational-rotational spectra.

Electronic spectra of diatomic molecules: vibrational and rotational structure of electronic spectra. Quantum theory of Raman Effect, Pure rotational Raman spectra, Vibrational Raman spectra, Polarization of light and the Raman effect, Applications. General theory of Nuclear Magnetic Resonance (NMR). NMR spectrometer, Principle of Electron spin resonance ESR. ESR spectrometer.

(*Mathematical details can be found in BJ. The students are expected to be acquainted with them but not examined in these.).

**References:**

1. Robert Eisberg and Robert Resnick, *Quantum physics of Atoms, Molecules, Solids, Nuclei and Particles*, John Wiley & Sons, 2$^{nd}$ ed, (ER).

2. B.H. Bransden and G. J. Joachain, *Physics of atoms and molecules*, Pearson Education 2nd ed, 2004 (BJ).
3. G. K. Woodgate, *Elementary Atomic Structure*, Oxford university press, 2nd ed, (GW).
4. G. Aruldhas, *Molecular structure and spectroscopy*, Prentice Hall of India 2nd ed, 2002 (GA).
5. Ira N. Levine, *Quantum Chemistry*, Pearson Education, 5th edition, 2003 (IL).

**Additional references:**

1. Leighton, *Principals of Modern Physics*, McGraw hill.
2. Igor I. Sobelman, *Theory of Atomic Spectra*, Alpha Science International Ltd. 2006.
3. C. N. Banwell, *Fundamentals of molecular spectroscopy*, Tata McGraw-Hill, 3rd ed.
4. Wolfgang Demtröder, *Atoms, molecules & photons*, Springer-Verlag 2006.
5. Sune Svanberg, *Atomic and Molecular Spectroscopy*, Springer, 3rd ed 2004.
6. C.J. Foot, *Atomic Physics,* Oxford University Press, 2005 (CF).

## Semester –IV

| Course Code | Title | Credits |
|---|---|---|
| | Solid State Physics and Devices | 4 |

**Unit-I: Diffraction of waves by crystal and lattice vibrations** **15 lectures**

Bragg law, Reciprocal Lattice Vectors, Reciprocal Lattice to SC, BCC and FCC lattice (Review). Scattered Wave Amplitude – Fourier analysis, Diffraction Conditions in reciprocal space, Brillouin Zones, Atomic form factor, Structure factor, Ewald construction.
Vibrations of Monoatomic Lattice, normal mode frequencies, dispersion relation. Lattice with two atoms per unit cell, normal mode frequencies, dispersion relation, Quantization of lattice vibrations,
Thermal conductivity – Lattice Thermal Resistivity, Umklapp Process, Imperfections.

**Unit-II: Diamagnetism and Paramagnetism** **15 lectures**

Langevin diamagnetic equation, diamagnetic response, Quantum mechanical formulation, core diamagnetism. Quantum Theory of Paramagnetism, Rare Earth Ions, Hund's Rule, Iron Group ions, Crystal Field Splitting and Quenching of orbital angular momentum; Adiabatic Demagnetization of a paramagnetic Salt, Paramagnetic susceptibility of conduction electrons.

**Unit-III: Magnetic Ordering** **15 lectures**

Ferromagnetic order- Exchange Integral, Saturation magnetization, Magnons, neutron magnetic scattering; Ferrimagnetic order, spinels, Yttrium Iron Garnets, Anti Ferromagnetic order. Ferromagnetic Domains – Anisotropy energy, origin of domains, transition region between domains, Bloch wall, Coercive force and hysteresis.

**Unit-IV: Semiconductor Physics** **15 lectures**

Energy band structure of Si, Ge, GaAs, temperature dependence of Fermi energy and carrier concentration. Drift, diffusion and injection of carriers; carrier generation and recombination process – Direct, Indirect, Surface, and Auger.
Continuity equation: Application of continuity equation- Steady state injection from one side.
Hall Effect, Four – point probe resistivity measurement; Carrier life time measurement by light pulse technique.
p-n junction: fabrication of p-n junction, Abrupt and linearly graded junctions and thermal equilibrium conditions.
Metal-Semiconductor contacts: Schottky barrier- Energy band relation, Capacitance and voltage characteristics, current voltage characteristics, Barrier height and carrier concentration measurement.
Metal-semiconductor field effect transistor (MESFET), MOSFET fundamentals, Measurement of mobility, channel conductance etc. from Ids vs, Vds and I ds vs Vg characteristics.

**Main References:**


1. Charles Kittel "*Introduction to Solid State Physics*", 7th edition John Wiley & sons.
2. J. Richard Christman "*Fundamentals of Solid State Physics*" John Wiley & sons.
3. M. A. Wahab "*Solid State Physics –Structure and properties of Materials*" Narosa Publications 1999.

4. M. Ali Omar "*Elementary Solid State Physics*" Addison Wesley (LPE).
5. H. Ibach and H. Luth, "*Solid State Physics – An Introduction to Principles of Materials Science*", 3rd edition, Springer International Edition (2004).
6. S.M. Sze, *Semiconductor Devices: Physics and Technology*, 2nd edition, John Wiley, New York, 2002.
7. B.G. Streetman and S. Benerjee, *Solid State Electronic Devices*, 5th edition, Prentice Hall of India, NJ, 2000.
8. W.R. Runyan, *Semiconductor Measurements and Instrumentation*, McGraw Hill, Tokyo, 1975.
9. Adir Bar-Lev, *Semiconductors and Electronic devices*, 2nd edition, Prentice Hall, Englewood Cliffs, N.J., 1984.

<u>**Semester –IV**</u>

| Course Code | Title | Credits |
|---|---|---|
| | Elective Paper-IV: VHDL, USB and Communication Interface | 3 |

**<u>Unit – I:</u> VHDL-1** **15 lectures**

Introduction to VHDL: VHDL Terms, Describing Hardware in VHDL, Entity, Architectures , Concurrent Signal Assignment , Event Scheduling, Statement concurrency, Structural Designs, Sequential Behavior, Process Statements, Process Declarative Region, Process Statement Part, Process Execution, Sequential Statements, Architecture Selection, Configuration Statements, Power of Configurations.

Behavioral Modeling: Introduction to Behavioral Modeling, Transport Versus Inertial Delay, Inertial Delay, Transport Delay, Inertial Delay Model, Transport Delay Model, Simulation Deltas, Drivers, Driver Creation, Bad Multiple Driver Model, Generics, Block Statements, Guarded Blocks.

Sequential Processing: Process Statement, Sensitivity List, Process Example, Signal Assignment Versus Variable Assignment, Incorrect Mux Example, Correct Mux Example, Sequential Statements, IF Statements, CASE Statements, LOOP statements, NEXT Statement, EXIT Statement, ASSERT Statement, Assertion BNF, WAIT statements, WAIT ON Signal, WAIT UNTIL Expression, WAIT FOR time_expression, Multiple WAIT Conditions, WAIT Time-Out, Sensitivity List Versus WAIT Statement, Concurrent Assignment Problem, Passive Processes.

**<u>Unit-II</u>: VHDL-2** **15 lectures**

Data Types: Object Types, Signal, Variables, Constants, Data Types, Scalar Types, Composite Types, Incomplete Types, File Types, File Type Caveats, Subtypes.

Subprograms and Packages: Subprograms Function, Conversion Functions, Resolution Functions, Procedures, Packages, Package Declaration, Deferred Constants, Subprogram Declaration, Package Body.

Predefined Attributes: Value Kind Attributes, Value Type Attributes, Value Array Attributes, Value Block Attributes, Function Kind Attributes, Function Type Attributes, Function Array Attributes, Function Signal Attributes, Attributes ‘EVENT and ,LAST-VALUE Attribute ‘LAST- EVENT Attribute, ‘ACTIVE and ‘LAST-ACTIVE Signal Kind Attributes, Attribute ‘DELAYED, Attribute ‘STABLE, Attribute ‘QUIET, Attribute TRANSACTION, Type Kind Attributes, Range Kind Attributes.

Configurations: Default Configurations, Component Configurations, Lower-Level Configurations, Entity-Architecture Pair Configuration, Port Maps, Mapping Library Entities, Generics in Configurations, Generic Value Specification in Architecture, Generic Specifications in Configurations, Board-Socket-Chip Analogy, Block Configurations, Architecture configurations.

**<u>Unit-III</u>: USB, USB Protocols and Communication Interface** **15 lectures**

USB Basics: Uses and limits, Evolution of an interface, Bus components, Division of Labor, Developing a Device.

Inside USB Transfers: Transfer Basics, Elements of a Transfer, USB 2.0 Transactions, Ensuring Successful Transfers, SuperSpeed Transactions.
A Transfer Type for Every Purpose: Control transfers, Bulk Transfers, Interrupt Transfers, Isochronous Transfers, More about time-critical transfers.
Enumeration: How the Host learns about devices: The Process,
Descriptors.
Control Transfers: Structured Requests for Critical Data: Elements of a Control Transfer, Standard Requests, Other Requests.
Chip Choices: Components of USB device.
How the Host Communicates: Device Drivers, Inside the Layers, Writing Drivers, Using GUIDs.
Communication Interface:
On board Communication Interface: Inter Integrated Circuit (I2C), Serial Peripheral Interface (SPI), Universal Asynchronous Receiver Transmitter (UART), Wire Interface, Parallel Interface, External Communication Interfaces: RS-232 & RS-485, USB, IEEE 1394 (Firewire), Infrared (IrDA), Bluetooth, Wi-Fi, ZigBee, GPRS.
The I2C-Bus Benefits designers and manufacturers.
Introduction to the I2C-Bus Specification.
The I2C-Bus Concept.
General Characteristics.
Bit Transfer.
Data validity, START and STOP conditions.
Transferring Data Byte format, Acknowledge.
Arbitration and Clock Generation. Synchronization, Arbitration, Use of the clock synchronizing mechanism as a handshake.
Formats with 7-Bit Addresses.
7-Bit Addressing. Definition of bits in the first byte.
10-Bit Addressing.
Definition of bits in the first two bytes, Formats with 10-bit addresses.
detailed study of Bluetooth: Overview, Radio Specifications and FHSS

**References:**


1. Douglas L. Perry, *VHDL programming by example*, Fourth edition, Tata McGraw- Hill.
2. Jan Axelson, *The Developers Guide "USB Complete*, Fourth Edition, Penram International Publishing (India) Pvt Ltd.
3. Shibu K. V., *Introduction to embedded systems*, Sixth Reprint 2012, Tata Mcgraw Hill.
4. William Stallings, *Wireless Communications and Networks*, 2$^{nd}$ edition Pearson.
5. Detailed studies of I2C Bus refer:
   I2C Bus Specification Version 2.1 by Philips (Pages 4-18 and 27-30) (Download from www.nxp.com)

## Semester –IV

| Course Code | Title | Credits |
|---|---|---|
| | Lab course - 4 | 4 |

**Group A:**

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Carrier lifetime by pulsed reverse method. | *Semiconductor electronics* by Gibson. |
| 2 | Simulation Experiment (NP) | Radiation Detection and Measurement, G.F. Knoll, 4th edition (John Wiley & Sons, New York, 2010) |
| 3 | Energy Band gap by four probe method. | *Semiconductor measurements* — Runyan. |
| 4 | Carrier mobility by conductivity. | *Semiconductor electronics* – Gibson. |
| 5 | Double slit- Fraunhofer diffraction (missing order etc.). | *Advance practical physics* - Worsnop and Flint. |
| 6 | I-V/ C-V measurement on semiconductor specimen. | *Semiconductor measurements* – Runyan. |

**Group B:**

| Sr. No | **Experiment** | **References** |
|---|---|---|
| 1. | Waveform Generator using ICs. | a. *Operational amplifiers and linear integrated circuits*- Coughlin & Driscoll.<br>b. *Op-amps and linear integrated circuit technology*: R. Gayakwad. *Operational amplifiers: experimental manual* C.B. Clayton. |
| 2. | Barrier capacitance of a junction diode. | *Electronic engineering* - Millman Halkias. |
| 3. | Measurement of dielectric constant (Capacitance). | *Semiconductor measurements* — Runyan. |
| 4. | Measurement of low resistance using lock-in amplifier | a. *Lock-in Amplifiers: Principals and application* by Mlmeade<br>b. *Lock-in Amplifiers: Principals and application* by R W Cohn |
| 5. | Temperature on-off controller using IC. | *Op-amps and linear integrated circuit technology* by Gayakwad. |

Minimum 3 experiments each from Group A and Group B to be performed and reported in the journal.

**Semester –IV**

| Course Code | Title | Credits |
|---|---|---|
| | Elective Lab course - 4 | 1 |

| Sr. No | **Experiment** | **Reference Books** |
|---|---|---|
| 1 | Write VHDL programs to realize: logic gates, half adder and full adder | Douglas L. Perry, *VHDL programming by example*, Fourth edition, Tata McGraw-Hill.<br>Manual of VHDL kit. |
| 2 | Write VHDL programs to realize:<br>2 to 4decoder, 8 to 3 encoder without priority, 4 to 1 multiplexer, 1 to 4 de- multiplexer. | |
| 3 | Write VHDL programs to realize:<br>SR- Flip Flop, JK – Flip Flop, T – Flip Flop. | |
| 4 | Interfacing stepper motor with VHDL | |
| 5 | Interfacing DC motor with VHDL | |
| 6 | Interfacing Relay with VHDL | |
| 7 | Experiment based on zigbee | |
| 8 | Experiment based on zigbee | |

Minimum 5 experiments to be performed and reported in the journal.

**Note:**

Journal should be certified by the laboratory in-charge only if the student performs satisfactorily the minimum number of experiments as stipulated above. Students who do not have certified journals, will not be allowed to appear for the practical examinations.

## Semester –IV

| Course Code | Title | Credits |
|---|---|---|
| | Research Project - 2 | 6 |