Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc.-I (Physics)

Syllabus

Academic Year: 2022-23

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Syllabi under Choice Based Credit System

1. Introduction:

Taking into consideration of the importance of the new and emerging subject of Photonics, Rajarshi Shahu Mahavidyalaya, Latur, steps to conduct a Master's Programme in Physics (Photonics) under the faculty of science. The two year M.Sc. degree programme in Physics (Photonics) is being offered by the Department of Physics and Electronics, which has been started through a special grant intended for this purpose from UGC under innovative programme.

Photonics is a Hi-Tech subject that has evolved as a result of the fusion of optical technology with electronics. Its deep impact in areas like communication, computing and control as well as in fields like medicine, industry, defense and entertainment has made Photonics as an independent subject on its own. The present M.Sc. Physics (Photonics) programme has been designed in such a way that it includes the essential subjects like Physics, Mathematics, Electronics, Modern Optics, and Lasers, which makes this a virtually stand-alone programme.

With reference to global changes occurring in higher education in various national and foreign universities, the syllabi of M.Sc. Physics is designed which is to be effectively implemented from June, 2022. The committee members of BoS in Physics (Photonics) also took the local need and employability of graduate students while framing the syllabus, keeping in view of the guidelines given in the UGC curriculum. The numbers of objectives are taken into consideration while reforming the syllabi.

2. Title of the Programme: **MSc. Physics**

3. Learning Objectives of the Programme:

The main objective is to create skilled minds and understanding of theoretical and mathematical knowledge essential for finding solutions of various interacting physical phenomenon. The entire course based on Mathematical Methods in Physics is included. It helps effectively to improve scientific attitude to solve the research oriented problems, problems of interacting systems. The professional education of the students begins while enrolling their names in the M.Sc. classes. The Board of Studies thought authentically that some sort of Job oriented syllabi is to be included and accordingly, Laser technology, Laser systems and its applications are the major part of the study. Fibre optics and its applications, Electronics, Photonic Materials, Nanotechnology and Photonic Devices and Industrial Photonics Engineering are the major areas which have given weightage in the curricula. Also various aspects of physics related to industries and research field have been covered. The laboratory work also includes theory and computer based Practicals to develop the skill and create interest of the students in the subject.

4. Programme Specific Outcomes/ Programme Outcomes:

This two-year master programme provides students with specialized knowledge and professional skills to prepare them for a career in the rapidly-growing field of photonics and optoelectronics. Photonics professionals work across a wide range of industries including research and development, telecommunications, and biomedical diagnostics. Upon successful completion, students will have the knowledge and skills to:

- Professionally address complex, multi-disciplinary real-world problems related to photonics and optoelectronic systems.
- Proficiently apply advanced, integrated technical knowledge in photonics and the underpinning sciences and scientific methods.
- Identify and critically evaluate current developments and emerging trends within the photonics sector.
- Identify the potential societal, ethical, and environmental impact of photonics activities.
- Engage in independent research, critical reflection and lifelong learning to continue to practice at the forefront of the discipline.
- Apply broad, solid, academic theoretical knowledge within a photonic system to acquire general knowledge within related fields.

5. Advantages of the Course:

Recent advances in Physics/Photonics technology for imaging, health care and consumer electronics have contributed unprecedented progress in every sphere of human activities. Photonics based companies and R & D institutions are growing day by day who need people trained in photonics and allied areas.

6. Duration of the Course:	**Two years**
7. Eligibility of the Course:	**B.Sc. Physics/ Electronics**
8. Strength of the Students:	**33**
9. Fees for Course:	As per University/College rules.
10. Admission / Selection procedure:	**Admission by merit through Registration**
11. Teacher's qualifications:	As per UGC/University/College rules
12. Standard of Passing:	As per UGC/University/College rules
13. Nature of question paper with scheme of marking:	As per UGC/University/College rules
14. List of book recommended:	Included in syllabus

15. List of Laboratory Equipment's, Instruments, and Measurements etc.:

List of major Laboratory Equipment's, Instruments, and Measurements:

Standard Laser kit	2 MHz Function Generator
Optoelectronics kit	10 MHz Pulse generator
Holographic Experimental kit	20 MHz Dual Trace Oscilloscope
CMOS CCD Zeeman Effect	Digital Multimeter
CCD camera Based Metal arc spectrometer	Dual output regulated power supply
Thin film coating kit	Fiber optic trainer kit
Potentiostat/ Galvanostat	Diffraction grating
High Power CO_2 Laser	Refractive index kit
OTDR	Refractive index Spectrometer
Fiber characterization kit	Brewster angle
Fiber communication kit	Solar kit
Michelson Interferometer	1 MHz Function Generator
Holographic Experimental Kit	Four Probe setup
Research optical bench	Keithley Source meter
Diode Laser (He-Ne; 10 mW)	UV-Vis spectrophotometer
Green Laser (100 mW)	G.M Counter with all accessories
Dyna-85# 7945	Simulation Package (Matlab software, Fem Lab) peripheral component bus based ADDA cards, DIO cards, DOIT cards)
PIO-ADC-01#1871	
PIO-ADC-01#2163	
PIO-ELV.SIM# 486	
PIO- STEEPER #1433	DYNA-51 # 1004-1009 Microcontroller trainers with emulator simulators cross compilers, universal programmers
PIO-SERDISP#419	
PIO-OPTORELAY#233	
PIO-Traffic # 367	
PIO-RT/TC#255	

16. Rules and regulations and ordinance if any: As per UGC/University/College rules

17. Course duration: Each theory course is of 60 Contact hours

18. Medium of the language: **English**

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

Curriculum Structure with effect from June, 2022

M.Sc. I (Physics) Syllabi under Choice Based Credit System

M.Sc. Physics – I (Semester I)

Course Code	Title of the course	Credits	Lectures /Week	Marks		
				CIA	SEE	Total
P-MMP-119	Mathematical Methods in Physics-I	04	04	40	60	100
P-CSM-120	Classical Mechanics-II	04	04	40	60	100
P-QUM-121	Quantum Mechanics-III	04	04	40	60	100
P-ELD-122	Electronics Devices-IV	04	04	40	60	100
P-LAC-123	Lab Course I (General Physics)	04	04	40	60	100
P-LAC-124	Lab Course II (Electronic Devices)	04	04	40	60	100
P-SEM-125	Seminar-I	01	01	25	--	25
	Total Credits	25				

Student Stay Hours: 25/Week

M.Sc. Physics – I (Semester II)

Course Code	Title of the course	Credits	Lectures /Week	Marks		
				CIA	SEE	Total
P-CMP-218	Condensed Matter Physics-V	04	04	40	60	100
P-AMP-219	Atomic and Molecular Spectroscopy-VI	04	04	40	60	100
P-MOO-220	Modern Optics-VII	04	04	40	60	100
P-TSM-221	Thermodynamics and Statistical Mechanics-VIII	04	04	40	60	100
P-LAC-222	Lab Course III (Condensed Matter Physics)	04	04	40	60	100
P-LAC-223	Lab Course IV (Optics)	04	04	40	60	100
P-SEM-224	Seminar -II	01	01	25	--	25
	Total Credits	25				

Student Stay Hours: 25/Week

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-I

Course Code: P-MMP-119

Core Course Title: Mathematical Methods in Physics-I

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1. To familiarize students with adequate background, conceptual clarity and knowledge of mathematical principles related to theory of matrices and its applications to understand the concept of Eigenvalues and Eigenvectors.

2. To equip students with standard matrix operations including addition, subtraction and multiplication.

3. To make students aware about computation of the inverse of a matrix, if it exists, using different methods.

4. To develop understanding about formation and solution of partial differential equations.

5. Solving the homogeneous and non-homogeneous linear equations of the first order using different methods.

6. To develop understanding of Cauchy's Residue Theorem, Cauchy Principle value, to evaluate Definite real Integrals.

7. To use the tools and methodologies in the formation of Fourier series for different functions.

Course Outcomes:

After successful completion of the course the students will:

1. Develop an understanding of the role of computation as a tool in real-world problem-solving.

2. Know how computation is used to solve the most common mathematical problems frequently arising in engineering, science and technology.

3. Be prepared to apply their knowledge of numerical techniques in their further study of advanced topics in mathematics as well as science and engineering.

4. Learn how to translate a variety of complex mathematical problems in traditional and emerging chemical engineering fields into numerical problems and how to tune numerical algorithms for effective and efficient solutions.

Unit I: Matrix Algebra and Eigenvalue Problems [Lectures: 15]

Matrix multiplication-Inner product, direct product, Diagonal matrices, trace, matrix Inversion, Example of Gauss-Jordon Inversion, Eigenvalues and Eigenvectors, Properties of Eigenvalues and Eigenvectors, Cayley Hamilton Theorem and applications, similar matrices and diagonalizable Matrices, Eigenvalues of some Special Complex Matrices, Quadratics forms, problems.

Unit II: Differential Equations **[Lectures: 15]**

Introduction, Definition, Solution of differential equation, Equation of first order and first degree: Variable Separable, Homogeneous equations, Linear equations, Bernoulli's equations, Exact differential equations.

Linear differential equation: Definition, Theorem, Operator D, Rules for finding the Complementary function, Rules for finding the particular integral, Problems.

Unit III: Calculus of Residues **[Lectures: 15]**

Introduction to complex variable, Singularities-Poles, Branch Points, Calculus of Residues-Residues Theorem, Cauchy Principle value, Evaluation of Definite Integrals, A Digression of Jordon's Lemma, Problems.

Unit IV: Fourier **[Lectures: 15]**

Periodic Functions, Fourier series, Dirichlet's Conditions, Advantages of Fourier Series, Useful Integrals, Determination of Fourier series constants (Euler's formulae), Function defined on two or more sub spaces, Even functions, Half range series, Change of Interval, Parseval's formula, Fourier series in complex form, Applications of Fourier Series, Practical Harmonic Analysis, Integral transform, Fourier integral theorem, Fourier transform, Problems.

Reference Books:

1) Mathematical Methods (Second Edition) S. R. K. Iyengar, R. K. Jain, Narosa, (2006)

2) Mathematical Physics, B.S. Rajput, Pragati Prakashan (2012)

3) Advanced Engineering Mathematics, H K Dass, S Chand (2006)

4) Matrices and tensors in physics, A. W. Joshi, Wiley (1995)

5) Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers (1965)

6) Mathematical Methods for Physicists, (6th Edition), Arfken & Weber, Elsevier Academic Press (2005)

7) Introduction to Mathematical Physics, Charlie Harper, Prentice-Hall of India Pvt. Ltd (2009)

8) Applied Mathematics for Engineers and Physicists (Third Edition), Louis A. Pipes and Lawrence R. Harvill, Courier Corporation (2014)

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-II

Course Code: P-CLM-120

Core Course Title: Classical Mechanics-II

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1. To acquire basic knowledge required to solve advanced problems involving the dynamic motion of classical mechanical systems using Newton's laws of motion,

2. To develop an understanding of Lagrangian and Hamiltonian formulation,

3. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations,

4. To use the law of conservation of energy and linear and angular momentum to solve dynamic problems.

Course Outcomes:

On successful completion of the course a student should be able to:

1. Define basic mechanical concepts related to discrete and continuous mechanical systems,

2. Describe the vibrations of discrete and continuous mechanical systems, motion of a mechanical system using Lagrangian-Hamilton formalism.

3. Demonstrate a basic knowledge of Calculus of Variations,

4. Illustrate the Canonical transformations, and

5. Solve complex problem in special theory of relativity.

Unit I: Central Force Problem: [Lectures: 15]

Introduction, Two body problem, the equation of motion and first integral, Equation of orbit, Kepler's laws, Kepler's problem, General analysis of orbits, Stability of orbits, Artificial satellites, Rutherford Scattering: Differential scattering cross-section, Rutherford Formulae for scattering.

Unit II: Variational Principle and Hamiltonian Formulation: [Lectures: 15]

Hamilton's principle, Hamiltonian, Generalized momentum, Constant of motion, Hamilton's canonical equations of motion, Deduction of canonical equations from Variational principle, Applications of Hamilton's equations of motion, Principle of least action, Proof of principle of least action.

Unit III: Canonical Transformations and Hamilton-Jacobi Theory [Lectures: 15]

Generating Functions, Illustrations of Canonical transformations, Condition for Transformation to be Canonical, examples. Poisson's Brackets, Poisson's theorem, Properties of Poisson's Brackets, Hamilton's Canonical equations in terms of Poisson's Brackets, Hamilton-Jacobi Equation, Problems.

Unit IV: Small Oscillations & Special Theory of Relativity [Lectures: 15]

Small Oscillations: Potential energy and equilibrium; Stable and unstable equilibriums; Small oscillations in a system with one degree of freedom; Normal coordinates; Normal modes and normal frequencies of vibration.

Special Theory of Relativity: Lorentz transformations and its consequences, Mass-Energy relation, Lagrangian formulation of relativistic mechanics, Particle accelerating under constant force, Hamiltonian formulation of relativistic mechanics, particle in an EM field.

Reference Books:

1) Classical Mechanics: Gupta, Kumar, Sharma, Pragati Prakashan (2010)

2) Classical Mechanics (3rd ed.), Herbert Goldstein, C. P. Poole, J. L. Safko, Addison-Wesley (2001).

3) Classical Mechanics, J. C. Upadhyay, Himalaya Publishing House, (2019)

4) N.C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill (1991)

5) Classical Mechanics, P.V. Panat, Narosa Publishing Home, New Delhi. (2012)

6) Classical Mechanics: A Textbook, Suresh Chandra, Alpha Science International Ltd. Oxford, U.K

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-III

Course Code: P-QUM-121

Core Course Title: Quantum Mechanics-III

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1) To equip students with the fundamentals of and latest trends in Quantum Mechanics required for CSIR-NET/SLET Examinations.

2) To develop the understanding about the concepts and principles of quantum mechanics: the Schrödinger equation, the wave function and its physical interpretation, and expectation values,

3) Solving simple potential problems using Schrödinger equation exactly,

Course Outcomes:

Upon successful completion of the course, it is expected that students will be able to:

1) Understand the basic principles of quantum mechanics;

2) Solve the Schrodinger equation to obtain wave functions for some basic, physically important potential, and estimate the shape of the wave function based on the shape of the potential,

3) Understand the role of uncertainty in quantum physics, and use the commutation relations of operators to determine whether or not two physical properties can be simultaneously measured.

4) develop a knowledge and understanding of perturbation theory and level splitting,

Unit I: Introduction to Quantum Theory [Lectures: 15]

Introduction, Wave-Particle Duality, Matter Waves, Group Velocity, Phase Velocity, relation between Group velocity and Phase velocity, Heisenberg's Uncertainty Principle, Illustrations of Heisenberg's Uncertainty Principle; Wave function and Wave packets. Schrodinger Wave Equation in Time Dependent and Independent Form, Concept of Probability and Probability Current Density, Operators, Eigenvalues and Eigen Functions, Basic Postulates of Quantum Mechanics.

Unit II: Simple potential problems [Lectures: 15]

Particle in a One Dimensional Box: Energy Quantization, Wave Function, Momentum Quantization; Particle in Three Dimensional Box: Energy Quantization; Infinite Square Well Potential; Potential Step; Rectangular Potential Barrier; Bound States: Delta Function Potential; Linear Harmonic Oscillator: Energy Levels; Parity Operation; Matrix Formulation of Quantum Mechanics: Dirac's Bra and Ket Notation, Properties of Dirac's

Bra and Ket, Linear operators, Matrix Representations of Vectors and Operators, Expectation Values.

Unit III: Theory of Angular Momentum **[Lectures: 15]**

Orbital angular momentum; Commutation relations: orbital angular momentum (Lx, Ly, Lz), Ladder Operators (L+, L-), Orbital angular momentum (Lx, Ly, Lz) and Total Angular Momentum (L2), Spin angular momentum (S2 and Sz); Eigenvalues of L2, Lz, J2, Jz; Addition of angular momentum; Angular momentum and rotations; Rotational symmetry and conservation of angular momentum, Rotational invariance of L2.

Unit IV: Approximation Methods **[Lectures: 15]**

Time Independent Perturbation theory: Introduction, Non-degenerate case: First and second order perturbation, perturbation to the linear harmonic oscillator problem, linear harmonic oscillator of charge Q perturbed by an electric field, perturbation theory for degenerate states, fine structure of hydrogen atom.

The variation method: - The Basic Principle: Upper bound on ground state energy, The Hydrogen atom through trial function in Variational parameters

($\Phi = A_1 \exp\left(-\alpha \frac{r}{a_0}\right), \Phi = A \exp\left(-\alpha [\frac{r}{a_0}]^2\right)$)

Reference Books:

1) Quantum mechanics - Ghatak and Loknathan

2) Quantum mechanics - L. I. Schiff (McGraw Hill)

3) Modern quantum mechanics - J. J. Sakurai (Addison Wesely)

4) A Text book of Quantum Mechanics- P.M.Mathews and Venkaresan K. (McGraw Hill, 2007.)

5) Quantum Mechanics-B.K.Agrwal and Hari prakash (Prentice-Hall of India, New Delhi, 2004.)

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-IV

Course Code: P-ELD-122

Core Course Title: Electronic Devices-IV

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1) To enhance comprehension capabilities of students through understanding of electronic devices.

2) To explain how transistor can be used to amplify a signal.

3) To illustrate the concept about the basic characteristics, construction, open loop and close loop operations of Operational-Amplifiers.

4) To enable students to analyze and design linear and non-linear circuits using Op-amp.

5) To familiarize students about the conversion of data from Analog to Digital and Digital to Analog.

Course outcomes:

Upon successfully studying this course, students will:

1) Be able to appreciate the role of semiconductor devices in various applications.

2) Analyze parameters of Op-amp and its applications.

3) Design and explain analog to digital conversion operations and vice versa.

4) Be able to use Op-amp as analog to digital and digital to analog converter.

5)

Unit I: Transistors and Microwave Devices [Lectures: 15]

Bipolar junction transistor (BJT), frequency response and switching of BJT, Field effect transistor (JFET), MOSFET and related devices, MESFET device structure and its operation, Tunnel diode, Transferred electron devices and Gunn diode, Avalanche transit time diode and IMPATT diode.

Unit II: Operational Amplifiers [Lectures: 15]

Introduction to Op-Amp, Schematic symbol, Characteristics of an Ideal Op-Amp, Types of Op-AMP (inverting and non-inverting), Op-AMP parameters, gain expression of inverting and non-inverting Op-Amps. Applications of Op-Amp such as Adder, Subtractor, Integrator and differentiator, Numerical problems.

Unit III: D/A and A/D Converters **[Lectures: 15]**

Introduction, Digital-to-Analog (D/A) Converter, Characteristic specification of D/A Converter, Weighted-Resistor D/A Converter (Voltage Output), Weighted-Resistor D/A Converter (Current Output), R-2R Ladder D/A Converter. Analog-to-Digital (A/D) Converter, Counter Controlled A/D Converter, Successive- Approximation A/D Converter, Flash-A/D Converter, Numerical Problems.

Unit IV: Microprocessors **[Lectures: 15]**

Architecture of 8085, Signals and timing diagram of 8085, Demultiplexing Address and Data bus, Instruction Set, Addressing modes, Assembly Language Programming of 8085 (Sum of an array, Minimum and Maximum of an array, Multiplication & Division of 4 & 8 bit numbers).

Recommended Books

1. Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad
3. Modern Digital Electronics by R.P. Jain Fourth Edition, (2010) Tata McGraw Hill Education Pvt. Ltd.
4. Semiconductor Optoelectronic devices-Pallab Bhattacharaya, PHI, (1995)
5. Digital Principles and Circuits- Dr. C. B. Agarwal, Himalaya Publishing House.
6. Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar (2002)
7. A Textbook of Applied Electronics – R S Sedha

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-V

Course Code: P-LAC-123

Core Course Title: Laboratory Course- I

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1) To understand the fundamentals of the MATLAB program.

2) To know the physical foundations of laser operation.

3) To make students familiar with Fourier series

4) To determine the sign of the charge carriers of conventional electric current.

5) To make aware students about Malu's law and explain how it is used to calculate intensity of polarized light passing through a polarizer with a tilted transmission axis.

Course Outcomes:

After successful completion of this course, students will be able to:

1) Collect, analyze, and explain data from physics experiments.

2) Comment on basic concepts and principles of geometrical optics, polarization, interference, and diffraction.

3) Describe basic optical phenomena and their applications.

4) Solve the matrix problem by using MATLAB.

5) Determine the direction of force on a moving charge or an electric current using the right-hand rule.

6) Prove that conventional electric current is carried by negatively charged particles.

7) Calculate the strength of a magnetic field from Hall Voltage measurements.

8) Determine the crystal structure from XRD pattern.

Laboratory Courses:

1. Calculation the wavelength of laser using Michelson Interferometer.
2. Observation of polarization properties of light and to verify Malu's law.
3. Verification of the existence of different harmonics and measure their relative amplitudes in complex wave (square, triangular wave etc.)
4. Determination of the type of majority charge carriers, charge carrier density and carrier mobility by using Hall Effect
5. Determination of the crystal structure of CdS thin film from given XRD Pattern.

6. Study of Computer – Applications of MS office (MS Word and MS Excel).
7. Addition, subtraction and multiplication of Matrices using Matlab.
8. Transpose, Inverse and eigenvalues of Matrices using Matlab.

Reference Books:

1. Wersnop and Flint. Advanced Practical Physics for Students,

2. S.O. Pillai Solid State Physics, (3rd Edition), New age International Publisher.

3. D.R. Behekar, Dr.S. T. Seman, V.M.Gokhale, P.G.Kale Practical Physics (Kitab Mahal Publication)

4. Stormy Attaway Matlab: A Practical Introduction to Programming and Problem Solving, Fourth edition (2016)

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-VI

Course Code: P-LAC-124

Core Course Title: Laboratory Course- II

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1) To provide the knowledge of microprocessor based system design,

2) To introduce basic concepts governing Multivibrator, like the familiar sinusoidal oscillators, are circuit with feedback, with the difference that they produce pulsed output,

3) To describe the operating characteristics of an Unijunction transistors,

4) To understand the operation and characteristics of controlled rectifiers.

5) Understanding of how solar cells function, as well as knowledge on solar cell operation.

Course Outcomes: After successful completion of laboratory course the students will be able to:

1) write simple programmes in assembly language,

2) find frequency of Astable Multivibrator,

3) describe the operating characteristics of an Astable Multivibrator,

4) identify the terminals and function of each of Unijunction transistor (UJT),

5) Describe the operating characteristics of an Optocoupler.

Laboratory Courses:

1. Program for two digit decimal counters by using 8085 microprocessor.
2. Astable Multivibrator to determine the pulse width, space width and frequency with the help of CRO.
3. Program for flashing display by using 8085 microprocessor.
4. Uni-junction transistor (UJT): study of the characteristics of Unijunction transistor (UJT) and calculation of the Intrinsic Stand- off Ratio (η).
5. Silicon Controlled Rectifier (SCR): Study of the voltage-current characteristics.
6. Solar cell: study of V-I characteristics of solar cell and determination of its efficiency.
7. Study the operation of an optocoupler and study of its characteristics.

8. Study the V-I characteristics and I-P characteristics of light emitting diode (LED).

Reference Books:

1. Leach and Malvino, Digital Principles and applications, Tata Mc-Graw Hill Pub. Co. Ltd. N.Delhi (5th Edition, 2002).
2. Ramakant Gaikwad, OP-AMPS and Linear integrated circuits, Prentice Hall, (1993)
3. B.S. Sonde, Data Converters, Tata Mc-Graw Hill Pub. Co. Ltd. (1974).

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-VII

Course Code: P-CMP-218

Core Course Title: Condensed Matter Physics-V

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1) To equip students with the fundamentals of latest trends in condensed matter physics required for NET/SET/GATE /SLET Examinations.

2) To develop the understanding of the basic concepts of Crystal Physics, Semiconductors, Magnetism and Superconductors.

3) To train students in analytical and numerical problem solving skills in solid state physics and magnetism.

Course Outcomes:

After successful completion of laboratory course the students will be able:

1) To account for crystalline materials using diffraction with concepts like the Ewald sphere, form factor, structure factor, reciprocal lattice, Brillouin zones and scattering amplitude, etc.

2) To determine structure of crystalline materials,

3) To estimate the charge carrier mobility and density in semiconductors,

4) To outline the importance of magnetic materials and superconductors in the present era.

Unit I: Crystal Physics **[Lectures: 15]**

Crystalline state of solids, Space Lattice, Unit Cell and Primitive Cell, Bravis Lattice in two/three dimensions, Co-ordination number, Some important crystal structure: simple cubic structure, SC, BCC, FCC, HCP, Bragg condition, Brillion zones for two and three dimensional Lattice, reciprocal lattice and their properties, structure factor, comparison of X-ray, electron and neutron diffraction methods.

Unit II: Crystal Defects **[Lectures: 15]**

Point defects (Schottky and Frenkel defects, equilibrium concentration of vacancies, color centers); line defects (screw and edge dislocations, Berger's vector and circuit, role of dislocations in plastic deformation and crystal growth); planar defects (stacking faults), observation of imperfections in the crystals.

Unit III: Semiconducting and Superconducting Properties [Lectures: 15]

Semiconductors: Energy band gap of Metals, Insulators and Semiconductors, effective mass, intrinsic carrier concentration, conductivity of semiconductors, impurity levels in doped semiconductors. Superconductors: Critical temperature, Meissner effect, Type-I and Type-II superconductors, Cooper Pair, BCS theory of superconductivity, flux quantization, Josephson Effect, SQUID, high-Tc superconductivity.

Unit IV: Magnetic Properties [Lectures: 15]

Origin of Magnetic Properties of Materials, Magnetic Susceptibility, Classification of Magnetic Materials, Theory of diamagnetism, classical and quantum theories of paramagnetism, exchange interactions, magnetic order (ferro-, anti-ferro- and ferrimagnetism), Weiss theory of ferromagnetism, ferromagnetic domains.

Reference Books:

1. Introduction to solid state physics - C. Kittel, 5th edn, John Wiley & Sons. Inc., New York (1976).

2. Solid state physics by A. J. Dekker, MacMillan India Ltd. (1986).

3. Solid state physics - N. W. Ashcroft and N. D. Mermin, HRW International edn.(1976).

4. Electronic properties of materials - R. E. Hummel, 2nd edn., Springer International (1994).

5. Solid state physics - J. S. Blakemore, 2nd edn., Cambridge University Press (1985).

6. Elementary Solid State Physics - Omer Ali.

7. Introduction to Solids – Azaroft.

8. Solid State Physics - Wahab.

9. Solid State Physics - Ajay kumar Saxena.

10. Solid State Physics - So Pillai.

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-VIII

Course Code: P-AMP-219

Core Course Title: Atomic and Molecular Spectroscopy-VI

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1) To explain the vector atom model for two valence electrons,

2) To study the Zeeman Effect, Paschen Back effect, and Stark effect,

3) To study the types of molecules and spectra of polyatomic molecules,

4) To study the energy levels and spectrum.

Course Outcomes:

Upon successful completion of this course student able to:

1) Discuss the energy levels of the hydrogen atom and their effect on optical spectra,

2) State and explain the properties of two valence electron atoms and importance of the Pauli Exclusion Principle,

3) Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields,

4) Discuss the importance of molecular physics,

5) Describe the difference between a singlet and triplet state,

6) State and justify the selection rules for various spectroscopic terms.

Unit I: Atomic Spectroscopy **[Lectures: 15]**

Investigation of spectra, Theoretical principles-quantum states of an electron in an atom, Hydrogen atom spectrum, electron spin and Stern-Gerlach experiment, spin–orbit coupling, fine structure-spectroscopic terms and selection rules- Hyperfine structure-Pauli exclusion principle- Alkali type spectra- LS & JJ coupling- Zeeman effect, Paschen-back effect, Stark effect, X-ray spectra

Unit-II: Rotational and Vibrational Spectroscopy **[Lectures: 15]**

The Rotation of the molecule - Rotational spectra-Rigid diatomic molecule- The intensities of spectral lines-effect of isotopic substitution- the non-rigid rotator – Techniques and instrumentation– applications. The vibrating diatomic molecule- The Simple harmonic oscillator- The anharmonic oscillator-Diatomic vibrating rotator- Born –Oppenheimer approximation- Techniques and instrumentation-applications.

Unit- III: Raman and Electronic Spectroscopy **[Lectures: 15]**

Introduction- classical & quantum theory of Raman effect-spectra- Pure rotational Raman spectra- Vibrational Raman spectra-Techniques and instrumentation-Applications Electronic spectra of diatomic molecules – Vibrational coarse structure-Franck- Condon Principle-Dissociation energy- Rotational fine structure of electronic vibration- Fortrat diagram.

Unit IV: Resonance Spectroscopy **[Lectures: 15]**

Introduction- Nature of spinning particle- Interaction between spin and a magnetic field - Larmor Precession – Theory of NMR-Chemical shift- relaxation Mechanism-Experimental study of NMR-Theory and experimental study of NQR- Theory of ESR-Hyperfine structure and fine structure of ESR- Experimental studies and applications - Mossbauer spectroscopy - Principle-Isomer shift-quadrupole effect - effect of magnetic field – Instrumentation-applications.

Reference Books:

1. Elements of Spectroscopy- S.L.Gupta, V.Kumar and R.C. Sharma, Pragati Prakashan Publications, 9th Edition, 2006.

2. Fundamental of Molecular Spectroscopy-Colin N.Banwell, and Elanie Tata McGraw hill, New Delhi, 1994

3. Straughan B.P and Walker .S., Spectroscopy – Vol.1,2,3, Chapman and Hall London, 1965

4. Molecular Spectroscopy – G. Aruldhas.

5. Introduction to Atomic Spectra – H.E. White, Mac-Graw Hill (1934).

6. Spectroscopy Vol,II and III BP Stranghen and S Walkar

7. Introduction to Molecular spectroscopy, C.M. Barrow

8. Spectra of diatomic molecules, G. Herzberg

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-VIII

Course Code: P-MOO-220

Core Course Title: Modern Optics-VII

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1) Develop understanding of optical phenomena based on the wave description of light,

2) Develop the knowledge of light as an electromagnetic field as it arises from first principles in Maxwell's equations,

3) To acquaint students about interference, and common interferometers,

4) To study the key concepts used in optics,

5) To study light polarization, and optics that manipulate polarization.

Course Outcomes:

After successful completion of the course students will be able to:

1) Explain how electromagnetic waves arise from Maxwell's equations,

2) Understand the relationship between the direction of propagation, and the directions of the electric and magnetic field.

3) Explain fundamental concepts in optics, including: amplitude, wavelength, frequency, phase, intensity, power, and refractive index.

4) Forecast the outcome of simple experiments that manipulate the polarization of the electromagnetic field.

5) Predict the behavior of common interferometers: Michelson, Fabry-Perot, Mach-Zehnder, and Sagnac.

Unit I: Electromagnetic theory **[Lectures: 15]**

Maxwell's equations, Energy density and momentum of the electromagnetic field, Poynting's theorem, Boundary conditions on an interface. Electromagnetic waves in a conducting medium. Polarization: Polarization ellipse, Different polarization states, Stokes parameters and their measurements. Jone's vectors and matrices, numerical problems.

Unit II: Interference **[Lectures: 15]**

Introduction, Michelson's interferometer, Mach-Zehnder interferometer, multiple beam interference, Fabry- Perot interferometer, Resolving power, frees spectral range and

Fineness of Fabry- Perot interferometer. Interference filters. Sagnac effect, Sagnac interferometer, numerical problems.

Unit III: Coherence **[Lectures: 15]**

Introduction, Theory of Partial coherence: Spatial and temporal coherence. Coherence length and coherence time. Degree of coherence, Fourier transforms spectroscopy. Intensity interferometry, Hanbury Brown-Twiss interferometer, numerical problems.

Unit IV: Diffraction **[Lectures: 15]**

Theory of Diffraction: Fresnel- Kirchhoff integral formula and its application to diffraction problems. Fraunhoffer and Fresnel diffraction. Fraunhoffer diffraction by single slit, double slit, multiple slits, diffraction grating, and circular aperture. Fresnel diffraction, Fresnel zones, Fresnel integrals, Spatial filters, numerical problems.

Reference Books:

1. Optics E.Hecht Pearson Edn (4th Ed) 2004 (Text)
2. Optics 3rd edition Ajoy Ghatak, Tata Mcgraw Hill companies (2005)
3. Quantum Electronics — Amnon Yariv, Academic Press (1998)
4. Principles of optics — Born and Wolf, Cambridge University Press (1981)
5. Fundamentals of Photonics — Saleh and Teich Wiley Intsc (2007)
6. Modern Optics — R.D, Guenther, John Wiley (1990) (Text)

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Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-X

Course Code: P-TSM-221

Core Course Title: Thermodynamics and Statistical Mechanics-VIII

Lectures/Week: 04 Marks: 100 Credits: 04 Lectures: 60

Learning Objectives:

1) To acquaint students about basic knowledge of thermodynamical quantities and its laws,

2) To acquaint students about applying the equipartition theorem to the number of degrees of freedom of a thermodynamical system.

3) To quantify entropy changes using a statistical approach.

4) To identify the relationship and correct usage of work, energy, heat capacity, specific heat and entropy

Course Outcomes:

On successful completion of this course a student should be able to:

1) State the thermodynamics laws and can differentiate between various forms of energy.

2) Apply the principles of statistical mechanics to selected problems,

3) Define and discuss the concepts of microstate and macrostate of a model system, the Boltzmann distribution and the role of the partition function,

4) Define the Fermi-Dirac and Bose-Einstein distributions; State their applicability

5) Apply the Fermi-Dirac distribution to the calculation of thermal properties of electrons in metals.

Unit I: Statistical Mechanics and Thermodynamics [Lectures: 15]

Basic concepts-Phase space, ensemble, a priori probability, Liouville's theorem, Fluctuations of physical quantities, Statistical Equilibrium, Thermodynamics – Thermodynamic Laws and Functions – Entropy, Free energy, Internal Energy, Enthalpy (definitions), Contact between statistics and thermodynamics – Entropy in terms of microstates, change in entropy with volume and temperature.

Unit II: Statistical Ensembles Theory [Lectures: 15]

Micro canonical Ensemble-Micro canonical distribution, Entropy and specific heat of a perfect gas, Canonical Ensemble-Canonical Distribution, partition function, Calculation of free energy of an ideal gas, Thermodynamic Functions, Energy fluctuations. Grand Canonical Ensemble - Grand Canonical distribution.

Unit III: Formulation of Quantum Statistics [Lectures: 15]

Distinction between MB, BE and FD distributions, Quantum distribution functions Boson and Fermion gas and their Boltzmann limit, Partition function. Ideal Bose gas,

Bose Einstein Condensation, Phonon gas, Liquid He4: Second Sound. Ideal Fermi gas:

Weakly and strongly degenerate, Electron gas: Free electron theory of metals.

Unit IV: Phase Transitions and Critical Phenomenon [Lectures: 15]

Phase Transitions, Conditions for phase equilibrium, first order Phase Transition: Clausius - Clayperon equation, Second order phase transition, the critical indices, Problems.

Reference Books:

1. Introduction to Statistical Mechanics, B. B. Laud, Macmillan, N Delhi, (1981).
2. Statistical Mechanics by R K Pathria, Pergamon press (1972).
3. Statistical and thermal Physics F Reif, McGraw-Hill (1965).
4. Statistical Physics, L D Landau and E M Lifshitz, Pergamon press (1958).

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Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-XI

Course Code: P-LAC-222

Core Course Title: Laboratory Work- III

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1) To teach MATLAB as a computational tool in physics and develop basic MATLAB programming skills,

2) To understand basic concept of refractive index,

3) To discuss transmission of light in given solid bar,

4) To understand various magnetic properties of materials,

5) To understand communication through internet,

6) To Verify Hartmann's formula using a prism spectrometer.

Course Outcomes: After successful completion of laboratory course the students will be able to:

1) Explore different types of programming including ODE solving and finding solution of Quadratic equation,

2) Define refractive index, critical angle and total internal reflection,

3) Learn magnetic properties of materials,

4) Calculate grating pitch by using grating equation.

Laboratory Courses:

1. Unknown wavelength of a given light source using Hartmann's formula.

2. Determination of the crystal structure of Aluminium thin film from given XRD Pattern.

3. Program for solution of quadratic equation in Matlab.

4. Program for computation of forward-Euler approximation to the solution of the ODE from x = 0 to x = 10.

5. Program for computation of solution of differential equations using 4th order Runge-Kutta method 6. Diffraction pattern due to ruled grating and hence calculating the grating pitch.

7. Observation of total internal reflection of light in transparent bar and finding the refractive index of transparent bar.

8. Diffraction using transmission grating and hence determining the grating pitch of transmission grating.

9. Determination of the magnetic susceptibility of FeCl3 solution by using Quincke's Method.

Reference Books:

1. G.D. Baruah, Lasers and Nonlinear Optics, Pragati Prakashan, Fourth Edition: 2014

2. S.P. Singh, Advanced Practical Physics Vol. I Pragati Prakashan, Eighteenth Edition: 2013

3. S.P. Singh, Advanced Practical Physics Vol. Ii Pragati Prakashan, Seventeenth Edition: 2013

4. B.S. Saxena, R.C. Gupta, P.N. Saxena, Solid State Physics, Pragati Prakashan, Fourteenth Edition: 2014 5. D.R. Behekar, Dr.S. T. Seman, V.M.Gokhale,P.G.Kale Practical Physics (Kitab Mahal Publication)

6. Stormy Attaway Matlab: A Practical Introduction To Programming And Problem Solving, Fourth Edition (2016)

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Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Core Course Physics-XII

Course Code: P-LAC-223

Core Course Title: Laboratory Work- IV

Lectures/Week: 04	Marks: 100	Credits: 04	Lectures: 60

Learning Objectives:

1) To verify practically the response of various special purpose electronic devices.

2) To understand and verify the characteristics of LDR, Phototransistor.

3) To examine the attenuation of the visible light by the set of transparent plates.

4) To measure the intensity of the transmitted light versus thickness and number of elements absorbing glass plates.

5) To Understand implementation of simple circuits based on a schematic diagram using logic gates.

Course Outcomes:

After successful completion of laboratory course the students will be able to:

1) Handle carefully optical components and instruments.

2) Design and conduct experiments as well as to analyze and interpret data.

3) Operate logic gates such as AND, OR, NOT, NAND, NOR, XOR.

4) Operate flip-flops such as T, R-S, J-K and D etc.

List of Experiments:

1. Study of laser beam cross section of given laser and evaluation of beam spot size.
2. Determination of the absorption coefficient of transparent solid by using laser.
3. Study the V-I characteristics of the given LDR under

a) Various illumination levels at constant supply voltage.

b) Various supply voltage at constant illumination level.

4. Determination of the angle of given wedge plate using laser and finding the thickness of wedge plate.
5. Verification of the truth table of following logic gates. AND, OR, NOT, NOR, NAND, Ex-OR.
6. Photo transistor: V-I characteristics.
7. Amplitude Modulation to measure the modulation index.
8. Study of flip-flops R-S, J-K, D and T type flip-flops using gates.

9. Programmes to perform the addition and subtraction of two 8-bit numbers by using micro controller 8051 instruction set.

10. Programmes to perform the multiplication and division of two 8-bit numbers by using micro controller 8051 instruction set.

Reference Books:

1. Gupta, Kumar, Hand Book of Electronics, Pragati Prakashan, Forty Edition: 2013 ISBN: 978-93-5140-01 Advanced Experimental

2. Varier, Joseph, Pradyumman, Techniques in Modern Physics, Pragati Prakashan, Second Edition: 2011

3. Kenneth Ayala, The 8051 Microcontroller, Thomson Delmar learning Third edition.

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Department of Physics and Electronics

M.Sc. I (Physics) Semester I

Question Paper Pattern for M.Sc. I (Sem I and II) w.e.f. June 2022

All Questions are compulsory

Q.1 Answer any THREE of the following questions. (Each 12 Marks) 36 Marks

a) Long answer question on Unit I

b) Long answer question on Unit II

c) Long answer question on Unit III

d) Long answer question on Unit IV

Q.2 Answer any THREE of the following questions. (Each 08 Marks) 24 Marks

a) Short answer question on Unit I

b) Short answer question on Unit II

c) Short answer question on Unit III

d) Short answer question on Unit IV