Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Structure and Curriculum of Four-Year Multidisciplinary Degree (Honors/Research) Programme with Multiple Entry and Exit option

Undergraduate Programme of Science and Technology

B.Sc. (Honors/Research) in Physics

Board of Studies

in

Physics

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

[UG III Year]

w.e.f. June, 2025

(In Accordance with NEP-2020)

Academic Year 2025-26

Review Statement

The NEP Cell reviewed the Curriculum of **B.Sc. (Honors/Research) in Physics** Programme to be effective from the **Academic Year 2025-26.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 08/04/2025

Place: Latur

NEP Cell
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **B.Sc. (Honors/Research) in Physics** Programme to be effective from the **Academic Year 2025-26.**

Date: 08/04/2025

Place: Latur

(Dr A. A. Yadav)
Chairperson
Board of Studies in Physics
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Members of Board of Studies in the Subject Physics
Under the Faculty of Science and Technology
Department of Physics and Electronics

Sr. No.	Name	Designation	In position
1	**Dr A. A. Yadav** Head, Department of Physics & Electronics Rajarshi Shahu Mahavidyalaya (Autonomous), Latur	Chairperson	HoD
2	**Prof. Dr. V. P. Pawar,** Head, Department of Physics, Maharashtra Udayagiri Mahavidyalaya, Udgir Dist: Latur	Member	V.C. Nominee
3	**Dr R. H. Kadam,** Shrikrishna Mahavidyalaya, Gunjoti, Omerga	Member	Academic Council Nominee
4	**Mrs Shyamala Bodhane** Head, Department of Physics, Xt. Xaviers College, Mumbai	Member	Expert from outside for Special Course
5	**Shri Gundu Sabde** Relyon Industries, Pune	Member	Expert from Industry
6	**Dr K. N. Shivalkar** Head, Department of physics, Mahatma Gandhi Mahavidyalaya, Ahmedpur Dist. Latur	Member	P.G. Alumni
7	**Dr D. G. Palke** Head, Department of Chemistry,	Member	Faculty Member
8	**Dr Dayanand Raje**	Member	Member from same Faculty
9	**Mr Atul More**	Member	Member from same Faculty
10	**Miss Mayuri Hawaldar**	Member	Member from same Faculty
11	**Miss Vishakha Patil**	Member	Member from same Faculty
12	**Miss Kranti Bhosale**	Member	Member from same Faculty

From the Desk of the Chairperson…

"Creativity is intelligence having fun" – Albert Einstein

I welcome you all. We have immense pleasure to share that our department is one of the star departments with the state-of-the-art facilities and has highly qualified and dignified faculty. The department addresses the critical challenges to face the society, industry and the academia. I take great pride in sharing that from the academic year 2023-24, development of our Physics curriculum is with the objectives and guidelines as per the National Education Policy 2020. National Education Policy 2020 is a comprehensive framework for education in India that aims to transform the existing education system. The NEP 2020 emphasizes a holistic and multidisciplinary approach to education, focusing on the overall development of students.

Our curriculum as per NEP 2020 reflects: A balanced mix of theoretical concepts, practical applications, and problem-solving skills. Incorporate interdisciplinary connections and encourage the integration of Physics with other subjects where appropriate. Inclusion of emerging topics and advancements in Physics, such as Quantum mechanics, Astrophysics, Nuclear Physics, Renewable Energy, etc. Design learning outcomes that emphasize conceptual understanding, critical thinking, analytical skills, and practical applications. Encourage project-based learning, hands-on experiments, and inquiry-based activities to foster active student engagement and exploration. Explore the integration of technology tools and resources. Promotes inclusivity, gender sensitivity, and addresses the needs of students with diverse backgrounds and abilities.

Our department organizes workshops, training programs, and seminars to update physics teachers about the revised curriculum, instructional strategies, and assessment methods. Encourage teachers to engage in professional development activities, research, and collaboration to enhance their pedagogical skills. Provide support and resources for teachers to integrate technology effectively into their teaching practices.

Our assessment methods are innovative, such as project portfolios, oral presentations, demonstrations, and performance-based assessments in addition to traditional written exams. Facilitate collaborations with research institutions, industries, and organizations to provide students with real-world exposure and opportunities for internships or mentor-ship programs.

Let me take the opportunity to thank and wish you all a great success.

(Dr A.A. Yadav)
Chairperson
Board of Studies in Physics

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

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Faculty of Science and Technology

Department of Physics and Electronics

Structure for Four Year Multidisciplinary Undergraduate Degree Programme in Physics Multiple Entry and Exit (In accordance with NEP-2020)

Year & Level	Sem	Major		Minor	GE/ OE	VSC/ SEC (VSEC)	AEC/ VEC	OJT, FP, CEP, RP	Credit per Sem.	Cum./Cr. per exit
		DSC	DSE							
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**
III 5.5	V	DSC IX: 04 Cr. DSC X: 04 Cr.	DSE-I :04 Cr	DSM III: 04 Cr. DSM IV: 02 Cr.	NA	VSC III : 02 Cr	VEC II: 02 Cr EVS	NA	22	132 Cr. UG Degree
	VI	DSC XI: 04 Cr. DSC XII: 04 Cr.	DSE-I :04 Cr	DSM V: 04 Cr.	NA	VSC IV : 02 Cr	NA	Academic Project: 04 Cr.	22	
	Cum. Cr.	16	08	10	-	06		04	44	

Exit Option**:** Award of UG Degree in Major with 132 Credits or continue with Major and Minor

Abbreviations:

1.	DSC	: Discipline Specific Core (Major)
2.	DSE	: Discipline Specific Elective (Major)
3.	DSM	: Discipline Specific Minor
4.	OE	: Open Elective
5.	VSEC	: Vocational Skill and Skill Enhancement Course
6.	VSC	: Vocational Skill Courses
7.	SEC	: Skill Enhancement Course
8.	AEC	: Ability Enhancement Course
9.	MIL	: Modern Indian Languages
10.	IKS	: Indian Knowledge System
11.	VEC	: Value Education Courses
12.	OJT	: On Job Training
13.	FP	: Field Projects
14.	CEP	: Fostering Social Responsibility & Community Engagement (FSRCE)
15.	CC	: Co-Curricular Courses
16.	RP	: Research Project/Dissertation
17.	SES	: Shahu Extension Services

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Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

B.Sc. (Honors/Research) in Physics

<table>
<tr><th>Year & Level</th><th>Semester</th><th>Course Code</th><th>Course Title</th><th>Credits</th><th>No. of Hrs.</th></tr>
<tr><td rowspan="16">I
5.5</td><td rowspan="7">V</td><td>301PHY5101
(DSC-IX)</td><td>Quantum Mechanics</td><td>04</td><td>60</td></tr>
<tr><td>301PHY5102
(DSC-X)</td><td>Solid State Physics</td><td>04</td><td>60</td></tr>
<tr><td>301PHY5201A
DSE-I(a)/
301PHY5201B
DSE-I(b)</td><td>Solar Energy
Or
Nano Materials and Applications</td><td>04</td><td>60</td></tr>
<tr><td>__________
(DSM-III)</td><td></td><td>04</td><td>60</td></tr>
<tr><td>__________
(DSM-IV)</td><td></td><td>02</td><td>30</td></tr>
<tr><td>301PHY5501
(VSC-III)</td><td>Renewable Energy for Daily Life</td><td>02</td><td>30</td></tr>
<tr><td>__________
(VEC-II)</td><td></td><td>02</td><td>30</td></tr>
<tr><td colspan="3">Total Credits</td><td>22</td><td></td></tr>
<tr><td rowspan="6">VI</td><td>301PHY6101
(DSC-XI)</td><td>Atomic and Molecular Physics</td><td>04</td><td>60</td></tr>
<tr><td>301PHY6102
(DSC-XII)
IKS</td><td>Statistical Physics and Introduction to Indian Astronomy</td><td>04</td><td>60</td></tr>
<tr><td>301PHY6201A
DSE-II(a)/
301PHY6201B
DSE-II(b)</td><td>Fundamentals of Digital Electronics
Or
Astronomy and Astrophysics</td><td>04</td><td>60</td></tr>
<tr><td>(DSM-V)</td><td></td><td>04</td><td>60</td></tr>
<tr><td>301PHY6501
(VSC-IV)</td><td>Computational Physics</td><td>02</td><td>30</td></tr>
<tr><td>AIPC/OJT-I</td><td>Academic Project</td><td>04</td><td>60</td></tr>
<tr><td colspan="3">Total Credits</td><td>22</td><td></td></tr>
<tr><td colspan="4">Total Credits (Semester I & II)</td><td colspan="2">44</td></tr>
</table>

Programme Outcomes (POs) for B.Sc. Programme	
PO1	**Disciplinary Knowledge** Comprehensive knowledge of science subjects which constitute the graduate programme and execution of scientific knowledge in the specific area.
PO2	**Scientific Outlook** The qualities of a science graduate such as observation, precision, analytical mind, logical thinking, clarity of thought and expression and systematic approach.
PO3	**Self-Directed Life-long Learning** Ability to appear for various competitive examinations or choose the post graduate programme or other related programme of their choice.
PO4	**Research Skills** Functional knowledge and applications of instrumentation and laboratory techniques to do independent experiments, interpret the results and develop research ethos.
PO5	**Problem Solving Skills** Analytical and logical skills and critical thinking to extract information from qualitative and quantitative data, formulate and solve problems in a systematic and rational manner.
PO6	**Professional Competence and Ethics** Aptitude and skills to perform the jobs in diverse fields such as science, engineering, industries, survey , education, banking, development and planning, business, public service, self-business etc. with human rationale and moral values.

Programme Specific Outcomes (PSOs) for B.Sc. Physics (Honors/Research)	
PSO No.	Upon completion of this programme the students will be able to
PSO 1	Distinguish core knowledge on various courses of Physics.
PSO 2	Recognize the concepts which help them in understanding physical phenomenon in nature.
PSO 3	Classify skills and competencies to conduct scientific experiments related to Physics.
PSO 4	Identify their area of interest and further specialize in the Physics.
PSO 5	Operate advanced knowledge and skills in job market for various technical industries.
PSO 6	Relate their knowledge and skills in carrying out independent work.
PSO 7	Analyze situations, search for truth and extract information, formulate and solve problems in a systematic and logical manner.
PSO 8	Discuss debate and communicate in a clear and logical way, with graduates in Physics and other fields.
PSO 9	Demonstrate relevant generic skills and global competencies.

Curriculum

Major and VSC Courses

Semester - V

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Faculty of Science and Technology

Department of Physics and Electronics

Course Type: DSC IX

Course Title: Quantum Mechanics

Course Code: 301PHY5101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. This course establishes the foundations of quantum mechanics through concepts such as wave-particle duality, the uncertainty principle, and Schrödinger's equation. It introduces the operator formalism and applies it to various problems involving one-dimensional potentials and central potentials. Special emphasis is given to the hydrogen atom problem.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Explain the limitations of classical physics and the motivation for the development of quantum mechanics.

CO 2. Derive and solve Schrödinger's wave equation in its time-dependent and time-independent forms.

CO 3. Apply Schrödinger's wave equation to various simple potential problems and interpret energy quantization and wave functions.

CO 4. Solve Schrödinger's equation for the hydrogen atom using spherical polar coordinates and separate variables to obtain solutions.

Unit No.	Title of Unit & Contents	Hrs.
I	**Origin of Quantum Mechanics**	**13**
	1. Introduction, Limitations of Classical Physics, 2. Particle Properties of Wave, Photoelectric Effect, 3. Experimental Observation of Photoelectric Effect, 4. Quantum Theory of Light, 5. Black Body Radiation, 6. The Compton Effect, Experimental Demonstration of the Compton Effect, 7. Wave Properties of Particles, De Broglie Waves, 8. De Broglie Wave Velocity, Wave and Group Velocities, 9. G. P. Thomson's Experiment for Electron Diffraction, 10. The Heisenberg Uncertainty Principle, Elementary Proof of Heisenberg Uncertainty Principle, 11. Applications of Heisenberg Uncertainty Principle, 12. The Wave Particle Duality. [Book 1 Chap. 3-4, Book 2 Chap. 1]	
	Unit Outcomes: UO1. Understand the quantum theory of light and the dual nature of electromagnetic radiation. UO2. Understand De Broglie's hypothesis of matter waves and apply it to calculate De Broglie wavelength and velocity.	

II	**Schrodinger's Wave Equation and Operators**	**12**
	1. Introduction, 2. The Wave Function and its Physical Interpretation, 3. The Wave Equation, Wave Equation in One Dimension, 4. Schrödinger's Wave Equation: Time Dependent Form (One Dimension and Three Dimension), 5. Probability Current Density and its Physical Significance, 6. Expectation Values, Expectation Values of Position, Momentum and Energy Operator, 7. Schrödinger's Wave Equation: Time Independent (Steady- State) Form, 8. Operators: Position, Momentum and Energy 9. Eigen Values and Eigen Functions. [Book 1 Chap. 7, Book 2 Chap. 3]	
	Unit Outcomes: UO1. Interpret the wave function and explain its physical significance in quantum systems. UO2. Apply the concept of operators, eigenvalues, and eigenfunctions to solve quantum mechanical problems.	
III	**Applications of Schrödinger's Steady-State Wave Equation**	**10**
	1. Introduction, 2. The Particle in a One-Dimensional Box: Energy Quantization, Energy levels of particle confined in One- Dimensional Box 3. The Particle in a One-Dimensional Box: Wave Functions, 4. The Particle in a One-Dimensional Box: Momentum Quantization, 5. The Particle in a Non-Rigid Box, 6. The Harmonic Oscillator, 7. The Harmonic Oscillator-Energy Level, Zero Point Energy, 8. The Particle in a Three-Dimensional Box: Energy Quantization. [Book 1 Chap. 8, Book 2 Chap. 4-6]	
	Unit Outcomes: UO1. Analyze the quantum harmonic oscillator and calculate its energy levels and wave functions. UO2. Apply the particle-in-a-box model to three dimensions and understand the quantization of energy in higher-dimensional systems.	
IV	**Quantum Theory of Hydrogen Atom**	**10**
	1. Schrödinger's Equation for the Hydrogen Atom in Spherical Polar Co-Ordinates, 2. Separation of Variables, Hydrogen atom wave function, 3. Quantum Numbers–Total Quantum Number, Orbital Quantum Number, Angular Momentum States, Magnetic Quantum Number, Angular Momentum, Spin Quantum Number, 4. Electron Probability Density, The Bohr Model of the Hydrogen Atom in a Spherical Polar Coordinate System,	
	Unit Outcomes: UO1. Understand quantum numbers (Total, Orbital, Magnetic, And Spin Quantum Numbers) and their physical significance. UO2. Explain angular momentum and its quantization in quantum mechanical systems.	

Learning Resources:

1. Arthur Beiser, Perspectives of Modern Physics- (McGraw-Hill International Editions) 1969.
2. S. L. Kakani and H. M. Chandaliya, Quantum Mechanics, Theory and Problems, (S. Chand & Sons) (2004)
3. R. Murugeshan, Modern Physics (S. Chand and Co. XIth Revised Edition)
4. Ajoy Ghatak and S. Lokanathan, Quantum Mechanics Theory and Applications, Published by Mc. Millan (2012).
5. Leonard I. Schiff, Quantum Mechanics McGraw-Hill 1968 (International Series in Pure and Applied Physics)
6. J. M. Cassels, Basic Quantum Mechanics, McGraw –Hill Publishers (1970)
7. P.M. Mathews and K. Venkatesan, A Text Book of Quantum Mechanics Tata McGraw –Hill Publishers (2002).
8. G. R. Chatwal, S. K. Anand, Quantum Mechanics, Publisher, Himalaya Publishing House, (1988)
9. Fundamentals of Quantum Mechanics - P. V. Pathak.

Course Type: Lab Course-IX
Course Title: Lab Course (Based on DSC-IX)
Course Code: 301PHY5103
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. This lab course aims to provide hands-on experience in C programming for solving and visualizing various quantum mechanical concepts, including the Schrödinger equation (time-dependent and independent), wave functions, quantum harmonic oscillators, and quantum random number generation, culminating in the ability to generate fixed waveforms and perform quantum measurements

Course Outcomes

After completion of the course, students will be able to-

CO 1. Develop C programs to solve time-dependent and time-independent Schrödinger wave equations.

CO 2. Implement numerical methods in C to analyze and visualize wave functions.

CO 3. Apply C programming to simulate quantum systems such as the quantum harmonic oscillator and Fourier transform.

CO 4. Generate and manipulate fixed waveform tables using C for quantum computing applications.

Practical No.	Unit
1	C Programming for Time-Dependent Schrödinger Wave Equation
2	C Programming for Time-Independent Schrödinger Wave Equation
3	C Programming for Solving the Wave Equation
4	C Programming for Sinusoidal Wave Equation
5	C Programming for Quantum Harmonic Oscillator
6	C Programming for Wave Function Visualization
7	C Programming for Quantum Random Number Generation
8	C Programming for Quantum Fourier Transform
9	C Programming for Quantum Measurement Simulation
10	Generating Fixed Waveform Tables Using C Programming

Learning Resources:

1. C Programming: A Modern Approach, K. N. King
2. The C Programming Language, Brian Kernighan and Dennis Ritchie
3. Expert C Programming: Deep Inside C, P.J. Plauger
4. Numerical Recipes in C, William H. Press et al.
5. C Programming and Numerical Analysis: An Introduction, Seiichi Nomura
6. Quantum Mechanics, David Morin.
7. Introduction to Quantum Mechanics, Richard L. Liboff.
8. Modern Quantum Mechanics, J.J. Sakurai and J. Naplet.
9. Perspectives of Modern Physics- (McGraw-Hill International Editions), Arthur Beiser,
10. Quantum Mechanics, Theory and Problems, (S. Chand & Sons), S. L. Kakani and H. M. Chandaliya.

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Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: DSC-X
Course Title: Solid State Physics
Course Code: 301PHY5102
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. This course introduces solid-state physics, equipping students with classical and quantum mechanical theories essential for understanding the physical properties of solids.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Provide a comprehensive foundation in crystallography, enabling students to apply these concepts to material science and solid-state physics.

CO 2. Equip students with a strong understanding of the free electron theory and its applications in explaining the behavior of metals.

CO 3. Understand the basic concept of band theory and its importance in explaining the electronic properties of solids.

CO 4. Understand the various applications of band theory in solid-state physics and materials science.

Unit No.	Title of Unit & Contents	Hrs.
I	**Crystal Structure:**	12
	1. Introduction, Single and Polycrystalline Crystals 2. Symmetry Considerations, Crystal Lattices, 3. Bases and Translation Vectors, 4. Unit Cell, Number of Atoms or Lattice Points Per Unit Cell 5. Atomic Radius: Simple Cubic (SC), Face Centered Cubic (FCC) and Body Centered Cubic (BCC) Structure 6. Number of Atoms in a Unit Cell, Coordination Number, Packing Fraction 7. Representation of Planes: Miller Indices, 8. Spacing of Planes in Crystal Lattice, 9. Point Group, Space Group, 10. Classification of Crystals, Bravais Lattices in Two and Three Dimensions, 11. Simple Crystal Structure: HCP, FCC, BCC, SC, 12. Structure of Diamond, ZnS, NaCl, 13. Numerical Problems [Book No.-1, Chapter-1]	
	Unit Outcomes: UO1. Explain the concept of crystal lattices and their significance in describing the arrangement of atoms in solids. UO2. Analyze simple crystal structures such as HCP, FCC, BCC, and SC, comparing their packing densities and atomic arrangements.	
II	**Free Electron Theory of Metals:**	11

	1. Introduction, 2. Outstanding Properties of Metals, 3. Drude-Lorentz Theory, 4. Electrical Conductivity, 5. Thermal Conductivity, Widemann-Franz Relation, 6. Somerfield Model, Tunnel Effect 7. Momentum Space, 8. Fermi Dirac Distribution, 9. Quantum Theory of Free Electron in A Box, 10. Free Electron Concentration: Nondegenerate and Degenerate Cases 11. Number of electrons per energy interval at T=0 K [Book No-1, Chapter-8]	
	Unit Outcomes: UO1. Understand the free electron theory and its significance in explaining the electrical, thermal, and optical properties of metals. UO2. Identify and explain the key properties of metals, such as high electrical and thermal conductivity, and their relationship to free electron behavior.	
III	**Band Theory of Solids**	**12**
	1. Introduction, 2. Splitting of Atomic Energy Levels into Bands, 3. Origin of Band Structure, Brillouin Zones, 4. Periodic Potential in Crystal, 5. Bloch Theorem, Bloch Function, Proof of Bloch Theorem, 6. Origin of Energy Gap, Value of Energy Gap, Valence Band, Conduction Band and Forbidden Band, 7. Behavior of Conductors, Insulators and Semiconductors on the Basis of Band Theory, 8. Effect of Impurity on Conductivity of Semiconductors, n-type and p-type Semiconductors, and Effective Mass of an Electron. [Book-2, Ch-23].	
	Unit Outcomes: UO1. Understand the band theory of solids and its role in determining the electronic and conductive properties of materials. UO2. Distinguish between valence, conduction, and forbidden bands and explain the significance of the energy gap in different materials.	
IV	**Applications of Band Theory**	**10**
	1. Introduction, 2. Kronig Penny Model: Basic Assumptions, Analytical Treatment, Energy of Lowest Energy Band 3. Hall Effect, Hall Voltage and Coefficient, 4. Mobility and Hall angle, Importance of the Hall Effect, 5. Experimental Determination of Hall Coefficient, Sources of Error and their Elimination 6. Introduction to Superconductivity and its Types, Properties that do not Change in Superconductivity Transitions, Properties that Change in Superconductivity Transitions, 7. Basics of Cryogenics. [Book-2: Ch-9, Ch-15, Ch-23]	
	Unit Outcomes: UO1. Learn the Kronig-Penney model to explain the formation of energy bands and	

	energy gaps in periodic potentials. UO2. Learn the basic concepts of cryogenics and their relevance to low-temperature physics, particularly in superconductivity and material studies.	

Learning Resources:

1. Solid State Physics – Saxena, Gupta, Saxena (Pragati Prakashan Meerut)
2. Physics for Degree Students-C.L. Arora and P.S. Hemesic (S. Chand 1st Edition 2014)
3. Introduction to Nanotechnology-K.K. Chattopadhyay And A.N. Banerjee.
4. Nanoscience and Technology-V.S. Murlidharan, A. Subramanian.
5. Solid State Physics and Electronics – R. K. Puri & V. K. Babar (S. Chand & Co.)
6. Solid State Physics – Puri & Babar (S. Chand & Co.)
7. Introduction to Solid State Physics -By Kittel, Wiley and Sons, 7th Edition.
8. Solid State Physics – R.L. Singhal (Kedarnath Ram Nath Co., Meerut)
9. Modern Physics – R. Murugeshan. (S. Chand & Co. XIth Revised Edition)
10. Solid State Physics- A.J. Dekkar (Macmillan India Ltd.2000)
11. Nanotechnology: Principles and Practices by Sulbha K Kulkarni, Capital Publishing Co. New Delhi.
12. Introduction to Nanotechnology, C.P. Poole Jr. And F.J. Ownes, Wiley Publication.
13. Origin and Development of Nanotechnology, P. K. Sharma, Vista International Publishing House
14. Developments in Nanotechnology-K. Krishna Reddn.
15. Solid State Physics - M. A. Wahab

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Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Lab Course
Course Title: Lab Course X
Course Code: 301PHY5104
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objectives

LO 1. Teach students how to analyze the electrical properties of semiconductor materials to determine bandgap energy, charge carrier characteristics, and temperature-dependent behavior.

LO 2. Develop skills among students in conducting experiments that relate to thermoelectric effects, solar cell efficiency, dielectric properties, and quantum phenomena in semiconductors.

Course Outcomes

After completion of the course, students will be able to-

CO 1. Analyze the electrical and thermal properties of semiconductor materials to determine bandgap energy and carrier characteristics.

CO 2. Demonstrate an understanding of thermoelectric effects, including the Seebeck effect, and their applications in temperature-dependent measurements.

CO 3. Evaluate the performance of electronic components such as thermistors, solar cells, and capacitors by measuring key electrical parameters.

CO 4. Apply experimental techniques to determine fundamental physical constants, such as Planck's constant and the dielectric constant, using semiconductor devices.

Practical No.	Experiment
1	Determination of Bandgap Energy of a Semiconductor via Temperature-Dependent Electrical Properties
2	Investigation of Thermoelectric EMF and Temperature Relationship Using the Seebeck Effect
3	Measurement of Temperature Coefficient of Resistance in a Thermistor and Classification as PTC or NTC
4	Measurement of Bandgap Energy of Thermistor Material via Resistance Variation with Temperature
5	Evaluation of Fill Factor (FF) and Conversion Efficiency (η) of a Solar Cell Using I-V Characteristics
6	Determination of Dielectric Constant of a Material Using Capacitance Analysis
7	Identification of Majority Charge Carriers and Measurement of Their Density and Mobility Using the Hall Effect
8	Determination of Planck's Constant via LED Threshold Voltage and Photon Energy Relationship
9	Measurement of Electrical Resistivity of a Semiconductor Using the Four-Point Probe Method

10	Determination of Flame Temperature Using Thermocouples, Optical Pyrometry, or Other Methods

Learning Resources:

1. Solid State Physics – Saxena, Gupta, Saxena (Pragati Prakashan Meerut)
2. Physics For Degree Students-C.L. Arora and P.S. Hemesic (S. Chand 1st Edition 2014)
3. Introduction to Nanotechnology-K.K. Chattopadhyay And A.N. Banerjee.
4. Nanoscience and Technology-V.S. Murlidharan, A. Subramanian.
5. Solid State Physics and Electronics – R. K. Puri& V. K. Babar (S. Chand & Co.)
6. Solid State Physics – Puri & Babar (S. Chand & Co.)
7. Introduction To Solid State Physics -By Kittel, Wiley and Sons, 7th Edition.
8. Solid State Physics – R.L. Singhal (Kedarnath Ram Nath Co., Meerut)
9. Modern Physics – R. Murugeshan. (S. Chand& Co. XIth Revised Edition)
10. Solid State Physics- A.J. Dekkar (Macmillan India Ltd.2000)
11. Nanotechnology: Principles and Practices by Sulbha K Kulkarni, Capital Publishing Co. New Delhi.
12. Introduction To Nanotechnology, C.P. Poole Jr. And F.J. Ownes, Wiley Publication.
13. Origin and Development of Nanotechnology, P. K. Sharma, Vista International Publishing House
14. Developments In Nanotechnology-K. Krishna Reddn.
15. Solid State Physics - M. A. Wahab

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: DSE-IA
Course Title: Solar Energy
Course Code: 301PHY5201A
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. To equip students with a comprehensive understanding of solar technology, including its principles, components, design, installation, maintenance, and economic/environmental impacts, preparing them for careers in the renewable energy sector.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Evaluate the characteristics of solar radiation and its interaction with the atmosphere, and analyze solar energy conversion techniques, including measurement methods and collector efficiency.

CO 2. Analyze various solar energy storage and utilization techniques, including solar thermal applications and solar fuel generation, for sustainable energy solutions.

CO 3. Understand the photovoltaic effect and semiconductor properties to analyze the design, characteristics, and fabrication of silicon-based solar cells.

CO 4. Analyze the structure, performance, and efficiency optimization of various solar cell technologies, including advanced photovoltaic materials and device architectures.

Unit No.	Title of Unit & Contents	Hrs.
I	**Solar Radiation:**	**12**
	1. Introduction 2. Origin, Solar Constant, 3. Spectral Distribution of Solar Radiation, 4. Absorption of Solar Radiation in The Atmosphere, 5. Global and Diffused Radiation, Seasonal and Daily Variation of Solar Radiation, 6. Measurement of Solar Radiation, Sun Tracking Systems, 7. Photo Thermal Conversion, 8. Solar Energy Collectors, Collector Efficiency and Its Dependence on Various	

	Parameters.	
	Unit Outcomes: UO1. Students will be able to explain the origin, spectral distribution, and absorption of solar radiation in the atmosphere, as well as evaluate the factors influencing global and diffused radiation, including seasonal and daily variations. UO2. Students will be capable of designing basic solar energy collection systems, including sun tracking mechanisms, and assess the efficiency of solar collectors by analyzing their dependence on various parameters.	
II	**Solar Energy**	**11**
	1. Storage of Solar Energy, 2. Solar Pond, 3. Solar Water Heater, 4. Solar Distillation, 5. Solar Cooker, 6. Solar Green Houses, 7. Solar Dryers, 8. Absorption Air Conditioning. 9. Solar Fuels: Electrolysis of Water, Photoelectrochemical Splitting of Water.	
	Unit Outcomes: UO1. Students will be able to design, analyze, and optimize various solar thermal applications considering energy efficiency and practical implementation. UO2. Students will understand and apply advanced concepts in solar energy storage, absorption air conditioning, and solar fuel production, including electrolysis and photoelectrochemical splitting of water, to develop sustainable energy solutions.	
III	**Fundamentals of Solar Cells**	**11**
	1. Photo Voltaic Effect, 2. Semiconductor Properties, 3. Energy Levels, Basic Equations, 4. P-N Junction and its Characteristics, 5. Fabrication Steps, 6. Thermal Equilibrium Condition, 7. Depletion Capacitance, Junction Breakdown, Heterojunction. 8. Silicon Based Solar Cells: Single Crystal, Polycrystalline and Amorphous Silicon Solar Cells	
	Unit Outcomes: UO1. Students will be able to explain the photovoltaic effect, semiconductor properties,	

	and the behavior of P-N junctions, including characteristics such as depletion capacitance and junction breakdown. UO2. Students will gain the ability to compare different silicon-based solar cell technologies (single crystal, polycrystalline, and amorphous).	
IV	**Device Physics**	**11**
	1. Solar Cell Device Structures, Construction, Output Power, Efficiency, Fill Factor and Optimization for Maximum Power, 2. Surface Structures for Maximum Light Absorption, 3. Current Voltage Characteristics in Dark and Light, 4. Operating Temperature Vs Conversion Efficiency, 5. Charge Carrier Generation, Recombination and Other Losses. 6. Cadmium Telluride Solar Cells, 7. Copper Indium Gallium Selenide Solar Cells, 8. Organic Solar Cells, 9. Perovskite Solar Cells, 10. Advanced Concepts in Photovoltaic Research.	
	Unit Outcomes: UO1. Students will be able to evaluate solar cell device structures, output power, efficiency, and fill factor, and apply optimization techniques to achieve maximum power output while considering factors such as operating temperature, charge carrier generation, and recombination losses. UO2. Students will gain the ability to analyze and differentiate between various advanced solar cell technologies.	

Learning Resources:

1. S P Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 1996.
2. Solid State Electronic Devices, Ben. G. Streetman, S. K. Banerjee, PHI Leaning Pvt. Ltd, 2000.
3. D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000.
4. Jasprit Singh, Semiconductor Devices, Basic Principles, Wiley, 2001
5. Stephen J. Fonash, Solar Cell Device Physics, 2nd edition, Academic Press, 2003.
6. H P Garg, J Prakash, Solar energy fundamentals and applications, Tata McGraw Hill publishing Co. Ltd, 2006.

Course Type: Lab Course
Course Title: Lab Course on Solar Energy
Course Code: 301PHY5202A
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. To impart understanding of various basic aspects related to solar energy systems and technology.

Course Outcomes

After completion of the course, students will be able to

CO 1. Examine how surface materials, angle of incidence, and cloud cover influence the absorption and intensity of solar radiation.

CO 2. Investigate the impact of temperature, light intensity, and electrical connections on the efficiency and output of solar cells.

CO 3. Construct and test simple solar-powered systems such as a fan, water distillation setup, and basic circuits for energy conversion.

CO 4. Assess the differences in solar radiation and artificial light intensity to determine their effectiveness in photovoltaic applications.

Practical No.	Experiment
1	Investigation of the Effect of Different Surfaces on Solar Absorption
2	Analysis of Solar Radiation and Temperature Variation
3	Study of Solar Radiation Dependence on Angle of Incidence
4	Effect of Cloud Cover on Solar Radiation Intensity
5	Comparison of Solar Radiation with Artificial Light Sources
6	Efficiency Assessment of a Solar Cell in Converting Sunlight into Electrical Energy
7	Construction of a Simple Solar-Powered Fan to Demonstrate Mechanical Work Using Solar Energy
8	Demonstration of Water Purification Through Solar Distillation
9	Effect of Light Intensity on Solar Cell Output Performance
10	Investigation of Temperature Influence on Solar Cell Performance
11	Analysis of Series and Parallel Connections of Solar Cells
12	Building and Testing Simple Solar-Powered Circuits

Learning Resources:

1. S P Sukhatme, Solar Energy: Principles of Thermal Collection and Storage, Tata McGraw Hill, 1996.

2. Solid State Electronic Devices, Ben. G. Streetman, S. K. Banerjee, PHI Leaning Pvt. Ltd, 2000.
3. D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, Taylor and Francis, 2000.
4. Jasprit Singh, Semiconductor Devices, Basic Principles, Wiley, 2001
5. Stephen J. Fonash, Solar Cell Device Physics, 2nd edition, Academic Press, 2003.
6. H P Garg, J Prakash, Solar energy fundamentals and applications, Tata McGraw Hill publishing Co. Ltd, 2006.

Course Type: DSE-I
Course Title: Nano Materials and Applications
Course Code: 301PHY5201B
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. To provide students the basic overview of nanomaterials and their applications.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Explain the significance of nanoscale systems and their unique properties based on length scales and quantum effects.

CO 2. Demonstrate an understanding of various synthesis techniques, including chemical vapor deposition, physical vapor deposition, and other physical/chemical methods.

CO 3. Utilize advanced characterization tools such as X-ray diffraction, SEM, STM, and AFM to investigate and characterize nanomaterials.

CO 4. Evaluate the role of nanomaterials in applications like energy storage, photocatalysis, and Biogenenic technologies, providing potential solutions for real-world problems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Nanoscale Systems**	**10**
	1. Introduction, 2. Length Scales in Physics, 3. Quantum Tunneling Effect, 4. Types of Nanostructures and Their Merits and Demerits (1D, 2D and 3D), 5. Band Structure Based on Surface Area and Size. 6. Numerical Problems	
	Unit Outcomes: UO1. Students will be able to explain fundamental concepts of nanoscale systems. UO2. Students will gain the ability to classify and assess different types of nanostructures (1D, 2D, and 3D) based on their merits, demerits, and applications.	
II	**Synthesis of Nanostructured Materials**	**12**
	1. Introduction, 2. Top Down and Bottom-Up Approaches,	

	3. Physical Methods: Chemical Vapor Deposition (CVD), 4. Physical Vapor Deposition (PVD), 5.Thermal Evaporation, 6. E-Beam Evaporation, 7. Chemical Methods: Electro-Deposition, 8. Spray Pyrolysis.	
	Unit Outcomes: UO1. Students will be able to explain and differentiate between top-down and bottom-up approaches for synthesizing nanostructures. UO2. Students will gain the ability to analyze and employ chemical methods for the synthesis of nanostructured materials.	
III	**Characterization Techniques**	**11**
	1. Introduction, 2. X-Ray Diffraction Methods, 3. Optical Microscopy: Scanning Tunneling Microscopy, 4. Atomic Force Microscopy, 5. Scanning Electron Microscopy, 6. UV-Vis Spectroscopy.	
	Unit Outcomes UO1. Students will be able to explain and utilize advanced characterization techniques such as X-ray diffraction, scanning tunneling microscopy, atomic force microscopy, and scanning electron microscopy to analyze the structural and surface properties of materials. UO2. Students will gain the ability to interpret data from UV-Vis spectroscopy and other optical microscopy techniques to evaluate the optical and electronic properties of materials at the micro and nanoscale.	
IV	**Nanomaterial Applications**	**12**
	1. Introduction, 2. Photonic Devices: LED, 3. Solar Cells, 4. Battery, 5. Photocatalysis, Sensors, 6. Thin Film Transistors, 7. Magneto Resistance, 8. Biogenenic Applications, 9. Optical Switching and Optical Data Storage.	

	Unit Outcomes UO1. Students will be able to analyze and explain the use of nanomaterials in photonic devices, energy storage systems, and electronic components to enhance performance and functionality. UO2. Students will gain the ability to assess the role of nanomaterials in cutting-edge applications.	

Learning Resources:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Shiv Chhatrapati Shikshan Sanstha's

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(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Lab Course

Course Title: Lab Course on Nano Materials and Applications-IB

Course Code: 301PHY5202B

Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. The course aims to provide students with a comprehensive toolkit of knowledge and skills related to nanomaterial synthesis

Course outcomes

After completion of the course, students will be able to

CO 1. Demonstrate the synthesis of semiconductor nanoparticles and analyze their structural properties.

CO 2. Characterize metal nanoparticles using surface plasmon resonance studies with a UV-Visible spectrophotometer.

CO 3. Determine the crystal structure and estimate the particle size of nanomaterials using XRD analysis.

CO 4. Investigate the optical properties of nanomaterials through transmittance spectra and light scattering techniques.

Practical No.	Unit
1	Synthesis of Semiconductor Nanoparticles
2	Synthesis of Nanoparticles Using the SILAR Method
3	Surface Plasmon Resonance Study of Metal Nanoparticles Using a UV-Visible Spectrophotometer
4	Determination of Crystal Structure of Nanomaterials from XRD Patterns
5	Estimation of Nanoparticle Size from XRD Patterns
6	Study of Transmittance Spectra of Nanomaterials in the UV-Visible Region
7	Visualization of Nanoparticle Formation Using the Tyndall Effect
8	Measurement of Nanoparticle Size Using Simple Filtration Techniques
9	Determination of Nanoparticle Suspension and Size via Light Scattering
10	Development of Nanomaterial-Based Antibacterial Coatings

Learning Resources:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Course Type: Minor-III
Course Title: Electricity and Magnetism
Course Code: 301PHY5301
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. The course aims to develop students' knowledge and skills in applying electrical and magnetic principles to real-world problems and technologies.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Apply vector algebra and calculus, including gradient, divergence, curl, and integral theorems, to solve problems in physics and engineering.
CO 2. Analyze electrostatic fields, electric potential, and Gauss's theorem to determine electric fields for various charge distributions.
CO 3. Apply fundamental laws of magnetostatics, including Biot-Savart's law and Ampere's circuital law, to analyze magnetic fields and material properties.
CO 4. Apply the principles of electromagnetic induction and Maxwell's equations to analyze inductance, energy storage, and electromagnetic wave propagation.

Unit No.	Title of Unit & Contents	Hrs.
I	**Vector Analysis**	**10**
	1. Introduction 2. Scalar and Vector Product, 3. Gradient, Divergence, Curl and Their Significance, 4. Vector Integration, Line, Surface and Volume Integrals of Vector Fields, 5. Gauss-Divergence Theorem and Stoke's Theorem of Vectors (Statement Only).	
	Unit Outcomes: UO 1. Students will be able to compute scalar and vector products, and interpret the physical significance of gradient, divergence, and curl in the context of vector fields. UO 2. Students will gain the ability to perform line, surface, and volume integrals of vector fields.	
II	**Electrostatics**	**14**
	1. Introduction 2. Electrostatic Field, Electric Flux, 3. Gauss's Theorem of Electrostatics. 4. Applications Of Gauss Theorem- Electric Field Due to Point Charge, Infinite Line of Charge, Uniformly Charged Spherical Shell and Solid Sphere, Plane Charged Sheet, Charged Conductor. 5. Electric Potential as Line Integral of Electric Field, 6. Potential Due to A Point Charge, 7. Electric Dipole,	

Unit No.	Title of Unit & Contents	Hrs.
	8. Uniformly Charged Spherical Shell and Solid Sphere. 9. Calculation of Electric Field from Potential. 10. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to use Gauss's theorem to calculate electric fields due to various charge distributions. UO2. Students will gain the ability to compute electric potential as a line integral of the electric field, determine potentials for point charges and dipoles, and derive electric fields from potential for uniformly charged systems, supported by solving numerical problems.	
III	**Magnetostatics**	**12**
	1. Introduction 2. Biot-Savart's Law and Its Applications- Straight Conductor, Circular Coil, Solenoid Carrying Current. 3. Divergence And Curl of Magnetic Field. 4. Magnetic Vector Potential. 5. Ampere's Circuital Law. 6. Magnetic Properties of Materials: Magnetic Intensity, Magnetic Induction, 7. Permeability, Magnetic Susceptibility. 8. Brief Introduction of Dia-, Para-And Ferromagnetic Materials. 9. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to use Biot-Savart's law to calculate magnetic fields for straight conductors, circular coils, and solenoids, and apply Ampere's circuital law to analyze magnetic fields in symmetric current distributions. UO2. Students will gain the ability to evaluate magnetic intensity, induction, permeability, and susceptibility, and classify materials as diamagnetic, paramagnetic, or ferromagnetic, supported by solving numerical problems.	
IV	**Electromagnetic Induction**	**09**
	1. Introduction 2.Faraday's Laws of Electromagnetic Induction, 3. Lenz's Law, 4. Self And Mutual Inductance, 5. L of Single Coil, M of Two Coils. 6. Energy Stored in Magnetic Field. 7.Maxwell`S Equations and Electromagnetic Wave Propagation: Equation of Continuity of Current, Displacement Current, 8. Maxwell's Equations, 9. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to explain and apply Faraday's laws of electromagnetic induction and Lenz's law to analyze induced electromotive force (EMF) and current in various systems, and calculate self and mutual inductance for coils.	

Unit No.	Title of Unit & Contents	Hrs.
	UO2. Students will gain the ability to derive and interpret Maxwell's equations, including the concept of displacement current and the continuity of current, and solve numerical problems related to energy stored in magnetic fields and electromagnetic wave propagation.	

Learning Resources:

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

Course Type: Lab Course
Course Title: Minor Lab Course –III (Based on Minor-III)
Course Code: 301PHY5303
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. The Laboratory Course aims to provide students with a fundamental understanding of the principles of electricity, magnetism, and their interactions.

Course Outcomes

After completion of the course, students will be able to-

CO 1. Demonstrate proficiency in using electrical measuring instruments such as multimeters, ballistic galvanometers, and oscilloscopes for various measurements.
CO 2. Analyze electrical circuits, including RC, LCR (series and parallel), and potentiometer-based setups, to determine key circuit parameters.
CO 3. Evaluate magnetic field variations, electrical conductivity, and resistance using experimental techniques like the magnetometer method and solenoid field measurement.
CO 4. Apply bridge methods and resonance techniques to compare capacitances, determine resistance, and measure AC frequency.

Practical No.	Unit
1	Use a multimeter for measuring: (a) resistance, (b) AC and DC voltages, (c) DC current, and (d) checking electrical fuses.
2	Measurement of charge and current sensitivity using a ballistic galvanometer.
3	Measurement of the coefficient of decrement of resistance (CDR) using a ballistic galvanometer.
4	Determination of high resistance by the leakage method using a ballistic galvanometer.
5	Comparison of capacitances using De Sauty's bridge.
6	Measurement of magnetic field strength (B) and its variation in a solenoid.
7	Study of the characteristics of a series RC circuit.
8	Study of a series LCR circuit and determination of its resonant frequency.
9	Study of a parallel LCR circuit and determination of its anti-resonant frequency.
10	Determination of low resistance using a potentiometer.
11	Measurement of the magnetic field along the axis of a circular coil.
12	Determination of the frequency of AC using a sonometer.
13	Measurement of the electrical conductivity of a graphite rod.
14	Study of the I-H curve using the magnetometer method.
15	Study of the front panel board of a cathode ray oscilloscope (CRO).

Learning Resources:

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed. 2011, Kitab Mahal

Shiv Chhatrapati Shikshan Sanstha's
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Faculty of Science and Technology
Department of Physics and Electronics

Course Type: Minor-IV
Course Title: Concepts of Modern Physics
Course Code: 301PHY5302
Credits: 02 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objective:

LO 1. To provide students with an understanding of the principles of modern physics and their applications in various fields.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Understand the particle nature of waves by analyzing key quantum phenomena such as the photoelectric effect, Compton effect, and black body radiation.
CO 2. Analyze the wave nature of particles through concepts like de Broglie waves, matter wave experiments, and the Heisenberg uncertainty principle.
CO 3. Apply Schrödinger's equation to analyze quantum systems, interpret wave functions, and evaluate probability distributions using quantum operators.
CO 4. Apply quantum mechanical principles to analyze energy and momentum quantization in confined particle systems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Particle Properties of Waves**	07
	1. Inadequacy of Classical Physics, 2. The Photoelectric Effect, 3. The Quantum Theory of Light 4. The Compton Effect, 5. Experimental Demonstration of Compton Effect 6. Gravitational Red Shift 7. Black body radiation, Einstein's explanation, 8. Planck's Radiation Law (statement only)	
	Unit Outcomes: UO1. Students will be able to explain the inadequacy of classical physics and demonstrate an understanding of the quantum theory of light and its implications. UO2. Students will gain the ability to analyze experimental demonstrations of quantum effects.	
II	**Wave Properties of Particles**	08
	1. De-Broglie Waves, 2. Wave Function, 3. De-Broglie Wave Velocity, 4. Wave and Group velocities 5. Experimental confirmation of matter waves, 6. Davisson Germer Experiment 7. Stern-Gerlach Experiment 8. Heisenberg Uncertainty Principle, 9. Illustration of the Principle through thought Experiments of Gamma ray microscope.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1. Students will be able to explain the concept of de-Broglie waves, wave functions, and the relationship between wave and group velocities. UO2. Students will gain the ability to interpret the Heisenberg Uncertainty Principle and illustrate its implications through thought experiments like the gamma-ray microscope.	
III	**Schrodinger's Equation**	**08**
	1. The Wave Function, 2. The Wave Equation, 3. Schrodinger's Equation: Time Dependent Form 4. Schrodinger's Equation: Time Independent Form 5. Probability Current 6. Expectation Values 7. Operators	
	Unit Outcomes: UO1. Students will be able to derive and solve both time-dependent and time-independent forms of Schrödinger's equation. UO2. Students will gain the ability to calculate probability currents, expectation values.	
IV	**Applications of Quantum Mechanics**	**07**
	1. The Particle in a One-Dimensional Box: Energy Quantization 2. The Particle in a One-Dimensional Box: Wave Functions 3. The Particle in a One-Dimensional Box: Momentum Quantization 4. The Particle in an Infinite Square Well Potential: Momentum Quantization 5. The Particle in a Three-Dimensional Box: Energy Quantization	
	Unit Outcomes: UO1. Students will be able to solve and interpret the energy and momentum quantization of particles in one-dimensional and three-dimensional boxes. UO2. Students will gain the ability to use quantum mechanical principles to model and analyze the behavior of particles in confined systems.	

Learning Resources:

1. Concept of Modern Physics by A. Beiser, Mc Graw Hill
2. Introduction to Modern Physics by H.S. Mani and G.K. Mehta
3. Atomic and Nuclear Physics by S.N. Ghosal (S. Chand & Co.)
4. Introduction to Special Theory of Relativity by R. Resnick (Wiley Eastern ltd)
5. Modern Physics by R. Murugeshan (S. Chand & Co.)
6. Introduction To Quantum Mechanics by S. N. Ghosal (Calcutta Book House)
7. Quantum Mechanics by A. K. Ghatak and S. Lokanathan (Macmillan, Delhi)
8. Quantum Mechanics by Powell and Craseman

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(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: VSC-III

Course Title: Renewable Energy for Daily Life

Course Code: 301PHY5501

Credits: 02 **Max. Marks: 50** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To teach the importance of energy in life.

LO 2. To raise awareness about human energy consumption patterns, overall energy consumption, and related environmental issues.

LO 3. To highlight potential alternative free-energy technologies.

LO 4. To emphasize the economic impacts of energy-related issues.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Know the vital concepts of energy, human consumption patterns, including the global energy cycle.

CO 2. Analyze various renewable and non-renewable energy sources, their potential, and their environmental and economic impacts.

CO 3. Evaluate energy conversion technologies, including solar, wind, ocean, and bioenergy, with a focus on efficiency and sustainability.

CO 4. Examine the role of the Internet of Energy in optimizing energy distribution, consumption, and market dynamics.

Unit No.	Title of Unit & Contents	Hrs.
I	**Energy**	**7**
	1. Introduction to Energy, 2. Atoms, Energy - Atom Interaction, 3. Energy Consumption, Units of Energy, 4. Energy Sources: Solar Energy, Geothermal Energy and Nuclear Energy - Bioenergy - Wind Energy- Ocean Energy 5. Fossil Fuels 6. Human Patterns of Energy Consumption: Internal Consumption and External Consumption, 7. Global Energy Cycle. 8. Internet of energy	
	Unit Outcomes: UO1. Understand the fundamental concepts of energy, its sources, and human consumption patterns. UO2. Analyze the impact of various energy sources on the environment and global energy cycles.	
II	**Renewable Energy**	**8**
	1. Pollution Free Renewable Energy Technologies	

Unit No.	Title of Unit & Contents	Hrs.
	2. Solar Energy: Potential, 3. Energy Conversion Through Photosynthesis, 4. Photovoltaic Conversion and Solar Thermal Energy Conversion. 5. Wind Energy: Potential and Energy Conversion Systems. 6. Ocean Energy: Potential and Energy Conversion Principles 7. Bioenergy: Resources and Types. 8. Energy and Economics: Gross Domestic Product (GDP) and Energy-Energy Market and Society - Energy Efficiency - Exergy - Exergy and Economics	
	Unit Outcomes: UO1. Understand the principles, potential, and conversion technologies of various pollution-free renewable energy sources. UO2. Analyze the relationship between energy, economics, and efficiency to assess the impact of renewable energy on society and the market.	
III	**Practical**	**30**
	1. Investigation of the Current-Voltage (I-V) Characteristics of a Solar Cell. 2. Determination of the Solar Constant. 3. Analysis of Color Sensitivity in Solar Cells. 4. Examination of the Impact of Dust Accumulation on Photovoltaic (PV) Panel Efficiency. 5. Study of the Operational Characteristics of a Solar Collector. 6. Evaluation of the Performance Characteristics of a Solar Cooker. 7. Measurement of Energy Storage and Power Density in a Capacitor. 8. Estimation of Oxygen Evolution Reaction (ORE) and Hydrogen Evolution Reaction (HRE) Overpotentials for a Given Electrode Material.	

Learning Resources:

1. Energy technology, non-conventional renewable and conventional-S. Rao and Dr. Parulkar.
2. Non-conventional energy sources –G.D. Rai
3. Solar energy: Principal of thermal collection and storage- S.P. Sukhatme
4. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill, 1996
5. Non-Convention Energy Resources, Shobh Nath Singh, Pearson, 2018
6. Web links and Video Lectures (e-Resources):
   E-book URL: https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html
   E-book URL: https://www.pdfdrive.com/non-conventional-energy-systems-nptel-d17376903.html
   E-book URL: https://www.pdfdrive.com/renewable-energy-sources-and-their-applications-e33423592.html
   E-book URL: https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources-e34339149.html
   https://onlinecourses.nptel.ac.in/noc18_ge09/preview

Semester - VI

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: DSC XI

Course Title: Atomic and Molecular Physics

Course Code: 301PHY6101

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. The course aims to provide basic knowledge about the structure of atoms and molecules.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Apply vector addition rules to determine the resultant angular momenta and their associated quantum numbers in atomic systems.

CO 2. Analyze the influence of magnetic and electric fields on atomic spectral lines and explain phenomena such as the Zeeman and Stark effects.

CO 3. Differentiate between rotational, vibrational, and electronic spectra of molecules and interpret their significance in molecular spectroscopy.

CO 4. Explain the quantum mechanical basis of the Raman effect and its applications in molecular structure analysis.

Unit No.	Title of Unit & Contents	Hrs.
I	**Atomic Structure and Vector Atom Model**	**13**
	1. Introduction, Rutherford's Experiment on Scattering of Alpha Particles, Sommerfeld's Relativistic Atom Model, 2. Drawbacks Of Earlier Atomic Models, 3. Vector Atom Model, 4. Quantum Numbers Associated with The Vector Atom Model 5. Coupling Schemes: L-S and J-J Coupling 6.Pauli Exclusion Principle and Its Applications 7. Some Examples of Electronic Configurations with Their Modern Symbolic Representation. 8. Magnetic Dipole Moment Due to Orbital Motion and Spinning of Electron 9. Stern-Gerlach Experiment 10. Numerical Problems	
	Unit Outcomes: UO1. Able to use vector addition rules to determine the resultant angular momenta and their associated quantum numbers UO2. Understand the orbital and spin motion of the electrons	
II	**Atomic Spectra and Atoms in External Fields**	**12**
	1. Spin-Orbit Coupling 2. Optical Spectra, Fine Structure of Sodium D-Lines 3. Larmor's Theorem, 4. Zeeman Effect	

	5.Quantum Mechanical Explanation of The Normal Zeeman Effect 6. Anomalous Zeeman Effect 7. Paschen- Back Effect 8. Stark Effect 10. Numerical Problems	
	Unit Outcomes: UO1. Recognize how transitions between different energy levels produce characteristic spectral lines in atomic spectra UO2. Describe the effects of magnetic and electric fields on spectral line.	
III	**Vibrational and Rotational Spectra of Molecules**	**10**
	1. Introduction, Diatomic Molecule 2. Molecular Spectra, Kinds of Molecular Spectra 3. Rotational Spectra, Frequency of Rotational Spectra, Representation of Rotational Energy Levels and Rotational Spectrum 4. Vibrational Spectra: Vibrations of a Molecule, Expression for Vibrational Energy Levels, Frequency Lines in Vibrational Spectra 5. Vibrational Rotational Spectra: Vibration-Rotation Energy Levels, Energy Level Diagram, Frequency of Spectral Lines 6. Potential Energy Curve 7. Electronic Spectra of Diatomic and Polyatomic Molecules 8. Luminescence, Fluorescence and Phosphorescence 9. Numerical Problems	
	Unit Outcomes: UO1. Comprehend the basic concepts of molecular spectroscopy, including the interaction of electromagnetic radiation with matter. UO2. Understand the different types of molecular spectra, including rotational, vibrational and electronic spectra.	
IV	**Raman Effect**	**10**
	1. Introduction, Stoke's and Anti Stoke's Lines, Characteristics of Raman lines 2. Experimental Arrangement to study Raman effect 3 Explanation of Raman effect on Quantum theory 4. Intensity of Raman lines 5. Raman effect: a Two-Step Process *6.* Pure Rotational Raman Spectra *7.* Applications of Raman Effect 8. Raman Scattering and Rayleigh Scattering 9. Numerical Problems	
	Unit Outcomes: UO1. Understand the quantum mechanical interpretation of the Raman effect, including the selection rules. UO2. Explain the mechanism of the Raman effect, including the concepts of inelastic scattering of photons and the interaction of light with molecular vibrations.	

Learning Resources:

1. Modern Physics by R. Murugeshan and Kiruthiga Siva Prasanth, S. Chand& Co.
2. Atomic Physics by J.B. Rajam, S. Chand& Co.
3. Physics for Degree students: C.L. Arora, Dr. P. S. Hemne, S. Chand & Co.
4. Atomic and molecular spectroscopy- Mool Chand Gupta, New Age international
5. Spectroscopy- Atomic and Molecular by Gurudeep R. Chatwal and Shyam Anand- Himalaya Publishing House
6. Elements of Spectroscopy by S. L. Gupta, V. Kumar, and R. Sharma, Pragati Prakashan
7. Fundamentals of Molecular spectroscopy by Colin N. Banwell, Tata Mc Graw Hill, New Delhi.
9. Spectroscopy by Straughan B.P. and walker, Vol 1,2,3, Chapman and Hall London
10. Molecular spectroscopy by G. Aruldas,

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Laboratory Course- XI
Course Title: Lab Course on Atomic and Molecular Physics
Course Code: 301PHY6103
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. To provide hands-on experience in understanding of optical phenomena such as interference, diffraction, and spectroscopy, etc.

Course Outcomes

After completion of the course, students will be able to-

CO 1. To understand and apply optical interference, diffraction, and spectroscopy principles for determining fundamental constants like wavelength, Rydberg constant, and Cauchy's constant.

CO 2. To analyze the effects of external factors such as magnetic fields on spectral lines through the study of the Zeeman effect.

CO 3. To investigate the photoelectric effect and determine Planck's constant, reinforcing the quantum nature of light.

CO 4. To develop experimental skills in using optical instruments like spectrometers, diffraction gratings, and telescopes for precise measurements in optics and photonics.

Practical No.	Unit
1	Determination of the Wavelength of a Monochromatic Source Using Newton's Rings.
2	Determination of Cauchy's Constant Using a Spectrometer.
3	Determination of the Rydberg Constant for Hydrogen.
4	Study of the Zeeman Effect: Splitting of Spectral Lines in a Magnetic Field.
5	Investigation of the Photoelectric Effect and Determination of Planck's Constant.
6	Diffraction Grating Experiment at Normal Incidence.
7	Determination of the Resolving Power of a Diffraction Grating.
8	Study of Molecular Fluorescence Excited by a Laser.
9	Determination of the Resolving Power of a Telescope.
10	Measurement of the Thickness of a Thin Wire Using the Air Wedge Method.

Learning Resources:

1. Modern Physics by R. Murugeshan and Kiruthiga Siva Prasanth, S. Chand& Co.
2. Atomic Physics by J.B. Rajam, S. Chand& Co.
3. Physics for Degree students: C.L. Arora, Dr. P. S. Hemne., S. Chand & Co.
4. Atomic and molecular spectroscopy- Mool Chand Gupta, New Age international
5. Spectroscopy- Atomic and Molecular by Gurudeep R. Chatwal and Shyam Anand- Himalaya Publishing House
6. Elements of Spectroscopy by S. L. Gupta, V. Kumar, and R. Sharma, Pragati Prakashan
7. Fundamentals of Molecular spectroscopy by Colin N. Banwell, Tata Mc Graw Hill, New Delhi.

11. Spectroscopy by Straughan B.P. and walker, Vol 1,2,3, Chapman and Hall London
12. Molecular spectroscopy by G. Aruldas,

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science and Technology

Department of Physics and Electronics

Course Type: DSC XII

Course Title: Statistical Physics and Introduction to Indian Astronomy

Course Code: 301PHY6102

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. To provide students an introduction to classical statistical mechanics in its traditional applications.

LO 2. To help students gain awareness of their rich heritage and the wealth of knowledge produced by the Ancient Indians.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Define and discuss the Boltzmann distribution and the role of the partition function.

CO 2. Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable.

CO 3. Examine the beginnings of the Indian Astronomy and describe the motion of celestial bodies relative to stars.

CO 4. Identify the time in Indian astronomy and discuss and interpret the importance of Indian calendar system.

Unit No.	Title of Unit & Contents	Hrs.
I	**Maxwell-Boltzmann Statistics**	**08**
	1. Introduction, 2. Three Kinds of Particles, Phase Space, Phase Cells, 3. Microstate and Macrostate, 4. Statistical Ensembles, Canonical Ensemble, Grand Canonical Ensemble, Microcanonical Ensemble, 5. Thermodynamic Probability 6. Maxwell-Boltzmann Energy Distribution Law 7. Numerical Problems	
	Unit Outcomes: UO1. Comprehend the basic concepts of statistical mechanics, including microstates, macrostates, and the statistical interpretation of thermodynamics. UO2. Derive the Maxwell-Boltzmann distribution function for the speed, energy, and momentum of particles in an ideal gas.	
II	**Quantum Statistics**	**07**
	1. Introduction, Need of Quantum Statistics 2. Development of Quantum Statistics. 3. Bose-Einstein Statistics 4. Fermi Dirac Statistics 5. Bose-Einstein Distribution Law	

	6. Fermi-Dirac Distribution Law. 7.Comparison of the Three Statistics.	
	Unit Outcomes: UO1. Learn the principles of Bose-Einstein statistics and its application to particles known as bosons UO2. Understand the principles of Fermi-Dirac statistics and its application to fermions (particles with half-integer spin).	
III	**Ancient Indian Astronomy and Celestial Sphere**	**15**
	1. **Ancient Indian Astronomy:** Introduction, Ancient Indian Astronomy, The Vedic Period and Vedangajyotisa, *Siddhanta*, Aryabhata I (1476 AD), Astronomers after Aryabhata, Contents of the *Siddhantas: Madhyamadhikara, Spastadhikara, Triprasnadhikara, Chandra- and Surya- Grahanadhikara*, Continuity in Astronomical Tradition (**Book- 2 Chapter- 1**) 2. **Celestial Sphere:** Introduction, Diurnal Motion of Celestial Bodies, Motion of Celestial Bodies Relative to Stars, Celestial Horizon, Meridian, Pole Star and Directions, Zodiac and Constellations, Equator and Poles (Visuvad Vrtta and Dhruva), Latitude of a Place and Altitude of Pole Star, Ecliptic and The Equinoxes. (**Book- 2 Chapter- 2**)	
	Unit Outcomes: UO1. Explain the contributions of ancient Indian astronomers and the evolution of astronomical concepts from the Vedic period to the Siddhantic era. UO2. Describe the celestial sphere, its reference points, and the motion of celestial bodies relative to the stars.	
IV	**Time in Indian Astronomy, Calendars and Indian Pancanga**	**15**
	1. Time in Indian Astronomy: Introduction, Civil Day and Sidereal Day, Solar Year and Civil Calendar, Solar Month and Lunar Month, Luni-Solar Year (or Lunar Year), Adhikamasa and Ksayamasa, Rtus (Seasons), Yuga System, Indian Eras- Kali Era, Vikrama Saka, Salivahan Saka, Kollam Era, Hejira Era, Time on Microcosmic Scale. (**Book- 2 Chapter- 5**) **2. Calendars and Indian Pancanga:** Introduction, Basis of Roam Calendar, Gregorian Calendar, Hindu Calendar- Luni Solar Calendar, Solar Calendar, Hindu Festivals, Islamic Calendar, Calendar and Indian Pancanga, what is Pancanga?, Tithi, Naksatra, Yoga, Karana, Vara. (**Book- 2 Chapter- 6**)	
	Unit Outcomes: UO1. Understand the concepts of time measurement in Indian astronomy. UO2. Explain the structure and significance of the Indian Pancanga, comparing it with other calendar systems such as the Gregorian and Islamic calendars.	

Learning Resources:

1. Heat, Thermodynamics and Statistical Physics by Brijlal, Dr. N. Subrahmanyam, P. S. Hemne.
2. S. Balachandra Rao, Indian Astronomy-Concepts, and Procedures, M.P. Birla Institute of Management, Bengaluru, 2014.
3. Thermodynamics and statistical physics- S.L Kakani, Sultan Chand & Sons
4. Thermodynamics & Statistical physics – J.K. Sharma, K.K. Sarkar, Himalaya Publishing House.

5. Statistical and thermal physics - Loknathan S. and Gambhir R.S., e-Book ISBN 9789390669783
6. Statistical Mechanics by Shrivastava R.K., Ashok J., eBook ISBN: 9789354430374
7. K. Ramasubramanian, A. Sule and M. Vahia, Eds. History of Astronomy: A Handbook, SandHI, I.I.T Bombay, and T.I.F.R., Mumbai, 2016.
8. Āryabhaṭīya of Āryabhaṭa, Edited with translation and notes, K. S. Shukla and K. V. Sarma, Indian National Science Academy, New Delhi, New Delhi, 1976.
9. B.V. Subbarayappa and K.V. Sarma, Indian Astronomy: A Source Book, Nehru Centre, Bombay, 1985.
10. Tantrasaṅgraha of Nīlakaṇṭha Somayājī, Translation and Notes, K. Ramasubramanian and M.S. Sriram, Hindustan Book Agency, New Delhi and Springer, 2011.
11. Karaṇapaddhati of Putumana Somayājī, Translation and Notes, R. Venkateswara Pai, K. Ramasubramanian, M.S. Sriram and M. D. Srinivas, Hindustan Book Agency, New Delhi and Springer, 2018.
12. M. S. Sriram, Man and the Universe- An elementary account of Indian Astronomy, (Unpublished 1993).
13. S. N. Sen and K. S. Shukla, Eds., History of Astronomy in India, 2nd Ed., INSA, New Delhi, 2001.

Course Type: Laboratory Course- XII
Course Title: Lab Course on Statistical Physics and Introduction to Indian Astronomy
Course Code: 301PHY6104
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. To equip students with Hands on experience C programs to simulate physical phenomena, such as the Boltzmann distribution, ideal gas behavior, probability-based events (e.g., dice throws, coin tosses), and astronomical calculations (e.g., escape velocity, parallax method, orbital periods), and analyze the results to understand underlying scientific principles.

Course Outcomes

After completion of the course, students will be able to-

CO 1. Develop C programs to simulate statistical distributions and physical phenomena, such as the Boltzmann distribution and ideal gas behavior.

CO 2. Implement probability-based simulations to analyze random events, including dice throws and coin tosses.

CO 3. Apply computational techniques to solve astrophysical problems, such as determining the distance to stars and calculating planetary orbital periods.

CO 4. Utilize C programming to model real-world physical concepts, including escape velocity and the Sun's apparent motion.

Practical No.	Unit
1	Simulation of the Boltzmann Distribution Using C Programming
2	C Program to Simulate an Ideal Gas and Calculate Pressure Using the Ideal Gas Law
3	C Program for Simulating Dice Throws
4	C Program to Calculate the Probability of Winning a Match
5	C Program to Determine the Probability of Heads and Tails in Coin Tosses
6	C Program to Calculate Escape Velocity
7	C Program to Determine the Distance to a Star Using Parallax Method
8	C Program to Calculate the Surface Area of the Sun
9	C Program to Simulate the Apparent Motion of the Sun
10	C Program to Calculate the Orbital Period of a Planet

Learning Resources:

1. C Programming: A Modern Approach, K. N. King
2. The C Programming Language, Brian Kernighan and Dennis Ritchie
3. Expert C Programming: Deep Inside C, P.J. Plauger
4. Numerical Recipes in C, William H. Press et al.
5. C Programming and Numerical Analysis: An Introduction, Seiichi Nomura
6. Heat, Thermodynamics and Statistical Physics by Brijlal, Dr. N. Subrahmanyam, P. S. Hemne.
7. Thermodynamics and statistical physics- S.L Kakani, Sultan Chand & Sons
8. Thermodynamics & Statistical physics – J.K. Sharma, K.K. Sarkar, Himalaya Publishing House.
9. Statistical and thermal physics - Loknathan S. and Gambhir R.S.,
10. Statistical Mechanics by Shrivastava R.K., Ashok J.,

Course Type: DSE II
Course Title: Fundamentals of Digital Electronics
Course Code: 301PHY6201A
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. To equip students with the foundational knowledge and skills to understand, analyze, and design digital circuits, including number systems, logic gates, Boolean algebra, and combinational/sequential circuits.

Course Outcomes:

After completion of the course, students will be able to

CO 1. Demonstrate the ability to perform number system conversions, binary arithmetic, and understand various digital coding schemes used in computing and communication systems.

CO 2. Understand the fundamental principles, operations, and implementations of basic, universal, and derived logic gates, and apply them in digital circuit design.

CO 3. Apply Boolean algebra principles and simplification techniques, including Karnaugh maps, to optimize logic expressions for efficient digital circuit design.

CO 4. Design and analyze combinational and sequential logic circuits, including adders, subtractors, flip-flops, and counters, for digital system applications.

Unit No.	Title of Unit & Contents	Hrs.
I	**Number Systems and Codes**	**10**
	1. Introduction, 2. Decimal Numbers, 3. Binary Numbers, 4. Octal Numbers, 5. Hexadecimal Numbers, 6. Inter-Conversions of Number Systems. 7. Binary Arithmetic, 8. Complements, 9. Digital Codes: Binary Coded Decimals (BCD), Gray Code, Excess-3 Code, Alphanumeric Code, Error Detecting Parity Code, 10. Problems.	
	Unit Outcomes: UO1. Students will be able to explain and perform inter-conversions between number systems. UO2. Students will gain the ability to interpret and use various digital codes.	
II	**Logic Gates**	**10**
	1. Introduction, 2. AND Operation, OR Operation, NOT Operation. 3. Basic Gates: NOT Gate, OR Gate, AND Gate	

Unit No.	Title of Unit & Contents	Hrs.
	4. Basic Gates Using Diode and Transistors. 5. Universal Gates: NAND Gate, NOR Gate, 6. Universal Property of NAND and NOR Gates, 7. Derived Gates: EX-OR and EX-NOR Gates 8. Bubbled Gates, Positive and Negative Gates 9. Concise Account of Logic Gates 10. Problems.	
	Unit Outcomes: UO1. Students will be able to explain the functionality of basic logic gates and universal gates, and demonstrate their implementation using diodes, transistors, and their universal properties. UO2. Students will gain the ability to design and analyze circuits using derived gates.	
III	**Boolean Algebra**	**12**
	1. Introduction, 2. Boolean Operations, 3. Logic Expressions, 4. Laws of Boolean Algebra, 5. De Morgan's Theorems, 6. Duality of Boolean Algebra 7. Evaluation of Boolean Expression 8. Simplification of Boolean Expressions Using Boolean Algebra Techniques, 9. SOP And POS Form of Boolean Expressions for Logic Network, 10. K-Map, Simplification of Boolean Expressions Using Karnaugh Map (2-Variables, 3-Variables, and 4 Variables), 11. Problems	
	Unit Outcomes: UO1. Students will be able to explain Boolean operations, laws, and De Morgan's theorems, and use them to evaluate and simplify Boolean expressions. UO2. Students will gain the ability to construct and use Karnaugh maps to minimize Boolean expressions and design efficient logic networks, supported by solving related problems.	
IV	**Combinational and Sequential Logic Circuits**	**13**
	1. Introduction, 2. Half Adder, Full Adder, 3. Four-Bit Parallel Binary Adder, 4. Half Subtractor, Full Subtractor with Suitable Examples. 5. Flip-Flops: S-R- Latch Using NAND and NOR Gate, Clocked S-R Flip Flop, J-K-Flip Flop, D- Type Flip Flop, T- Type Flip Flop (Characteristic Table, Characteristic Equation, Excitation Table, and State Diagram) 6. Preset and Clear Operations, 7. Race-Around Condition, 8. Master Slave JK Flip-Flop. 9. Types of Counters, Modulus of a Counter,	

Unit No.	Title of Unit & Contents	Hrs.
	10. Mode-8, Mod-8 Asynchronous Counter, Synchronous Counter.	
	Unit Outcomes: UO1. Students will be able to design and implement combinational circuits. UO2. Students will gain the ability to explain the working of flip-flops.	

Learning Resources:

1. Digital Principles and Applications- A. P. Malvino, McGraw Hill International Editions (Third Edition)
2. Modern Digital Electronics- R.P. Jain, Tata McGraw Hill Pub. Company (IVth Edition)
3. Digital Principles and Circuits- Dr. C.B. Agarwal, Himalaya Publications.
4. Digital Fundamentals-Thomas L. Floyd, Universal Book Stall
5. Digital Electronics with Practical Approach- G. N. Shinde, Shivani Pub., Nanded
6. Digital Electronics: An Introduction to Theory and Practice-William H. Gothmann, PHI
7. Digital principles and applications by Donald P. Leach & Albert Paul Malvino, (Glencoe, 1995)

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Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Lab Course
Course Title: Lab Course on Fundamentals of Digital Electronics
Course Code: 301PHY6202A
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. To provide hands-on experience in designing, implementing, and testing digital circuits, reinforcing theoretical knowledge with practical application, and fostering problem-solving skills.

Course Outcomes

After completion of the course, students will be able to

CO 1. Understand the functionality and applications of basic logic gates and their implementations using universal gates.

CO 2. Design and analyze combinational circuits such as adders and subtractors for arithmetic operations.

CO 3. Apply Boolean algebra and Karnaugh maps to simplify logic expressions and optimize digital circuits.

CO 4. Comprehend the working principles of flip-flops and their role in sequential logic circuits.

Practical No.	Unit
1	Study of Basic Logic Gates
2	Implementation of Basic Gates Using NAND Gate
3	Implementation of Basic Gates Using NOR Gate
4	Design and Analysis of Half Adder and Full Adder
5	Verification of De Morgan's Theorems
6	Implementation of Boolean Expressions Using K-Map from a Given Truth Table
7	Design and Analysis of Half Subtractor and Full Subtractor
8	Study of S-R, J-K, and D Flip-Flops
9	Analysis of NAND and NOR Gates as Universal Gates
10	Construction of Ex-OR and Ex-NOR Gates Using Basic Logic Gates
11	Construction of Ex-OR and Ex-NOR Gates Using Universal Gates

Learning Resources:

1. Digital Principles and Applications- A. P. Malvino, McGraw Hill International Editions (Third Edition)
2. Modern Digital Electronics- R.P. Jain, Tata McGraw Hill Pub. Company (IVth Edition)
3. Digital Principles and Circuits- Dr. C.B. Agarwal, Himalaya Publications.
4. Digital Fundamentals-Thomas L. Floyd, Universal Book Stall
5. Digital Electronics with Practical Approach- G. N. Shinde, Shivani Pub., Nanded
6. Digital Electronics: An Introduction to Theory and Practice-William H. Gothmann, PHI
7. Digital principles and applications by Donald P. Leach & Albert Paul Malvino, (Glencoe, 1995)

Course Type: DSE II
Course Title: Astronomy and Astrophysics
Course Code: 301PHY6201B
Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. To imbibe the concepts of astronomy and astrophysics to the students.

Course Outcomes:

After completion of the course, students will be able to

CO 1. Understand fundamental astronomical concepts, including celestial coordinate systems, time measurement in astronomy.

CO 2. Understand the structure, motion, and composition of celestial bodies in the solar system.

CO 3. Gain an understanding of various astronomical techniques, including electromagnetic radiation principles, magnitude systems, telescope basics, and methods for determining stellar properties such as temperature, radius, and luminosity.

CO 4. Understand the fundamental properties of the Sun, its atmospheric layers, solar activity, and phenomena such as sunspots, limb darkening, and the solar neutrino puzzle.

Unit No.	Title of Unit & Contents	Hrs.
I	**Fundamentals of Astronomy**	**10**
	1. Brief History of Astronomy (Geocentric Universe, Heliocentric Universe), 2. Co-Ordinate Systems, (Celestial Sphere, Horizon, Equatorial Co-Ordinate Systems), 3. Greenwich Sideral Time, 4. Local Sideral Time, Zonal Time, 5. Hour Angle and Mean Solar Time, 6. Astronomical Distance, Astronomical Unit (AU), 7. Light Year, Parsec, 8. Distance Measurement in Astronomy-Stellar Parallax	
	Unit Outcomes: UO1. Students will be able to explain the transition from geocentric to heliocentric	

Unit No.	Title of Unit & Contents	Hrs.
	models of the universe. UO2. Students will gain the ability to calculate and interpret time systems and measure astronomical distances using units like Astronomical Units (AU), light years, parsecs, and stellar parallax.	
II	**The Solar Family**	**10**
	1. Kepler’s Laws of Planetary Motion, 2. The Earth’s Orbit and Spin, 3. The Moon’s Orbit and Spin. 4. The Planets in The Solar System 5. The Terrestrial and Jovian Planets, Structure, 6. Composition and Atmospheres of The Planets, 7. Ring Systems and Satellites of The Planets, 8. Asteroids, Meteors and Meteorites, Comets and Their Origin, 9. Solar and Lunar Eclipses, 10. Origin of The Solar System: The Nebular Hypothesis.	
	Unit Outcomes: UO1. Students will be able to explain Kepler’s laws of planetary motion, analyze the Earth’s and Moon’s orbits and spins. UO2. Students will gain the ability to classify and explain the characteristics of asteroids, meteors, meteorites, and comets, interpret solar and lunar eclipses, and evaluate the Nebular Hypothesis as a model for the origin of the solar system.	
III	**Astronomical Techniques**	**15**
	1. Photon and Non-Photon Astronomy, Photons (Electromagnetic Waves), 2. Wavelength and Frequency, 3. Photon Energy, Temperature, 4. Electromagnetic Frequency Bands – Windows in Astronomy 5. Black Body Radiation- Planck Laws, 6. Wien Displacement Law, Brightness, 7. Radiant Flux and Luminosity. 8. Magnitude Systems: Apparent and Absolute Magnitudes, Distance Modulus; 9. Determination of Temperature and Radius of a Star Atmospheric Effects (Absorption, Seeing)- Basics of Telescopes - Noise and Statistics - Photon Detectors - Basics of Photometry - Spectroscopy and Polarimetry.	
	Unit Outcomes:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1. Students will be able to explain the properties of photons, electromagnetic waves, and black body radiation. UO2. Students will gain the ability to use magnitude systems (apparent and absolute magnitudes, distance modulus) to determine stellar properties, evaluate atmospheric effects on observations, and understand the principles of telescopes, photometry, spectroscopy, and polarimetry for astronomical data analysis.	
IV	**The Sun as a Star**	**13**
	1. Introduction, 2. The Sun as a Star, 3. Solar Parameters, 4. Solar Atmosphere, 5. Solar Photosphere, 6. Chromosphere, 7. Corona, Solar Activity, 8. Sunspots and Sunspot Cycle, 9. Solar Limb Darkening, 10. Solar Neutrino Puzzle.	
	Unit Outcomes: UO1. Students will be able to describe the solar atmosphere, including the photosphere, chromosphere, and corona, and explain key solar parameters and phenomena such as solar limb darkening and the solar neutrino puzzle. UO2. Students will gain the ability to interpret solar activity, including sunspots and the sunspot cycle, and evaluate their impact on solar dynamics and space weather.	

Learning Resources:

1. Modern Astrophysics – B.W. Carroll and D.A. Ostlie, 1996, Addison-Wesley Publishing Co., Inc.
2. The Physical Universe: An Introduction to Astronomy – Frank H. Shu, 1982, University Science Books, Sausalito, California
3. Astrophysics by Baidyanath Basu
4. Introduction to Astrophysics by K D Abhyankar

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Lab Course
Course Title: Lab Course on Astronomy and Astrophysics
Course Code: 301PHY6202B
Credits: 01 **Max. Marks: 50** **Hours: 30**

Learning Objective

LO 1. A lab course in Astronomy and Astrophysics aims to provide hands-on experience, fostering an understanding of astronomical concepts, scientific methods, and data analysis skills through practical observations and experiments.

Course outcomes

After completion of the course, students will be able to

CO 1. Analyze the radiation pattern of the Sun to estimate its effective surface temperature and luminosity.

CO 2. Measure and interpret atmospheric extinction effects on starlight using observational data.

CO 3. Determine the distance to celestial objects such as the Moon and star clusters using parallax and main sequence fitting methods.

CO 4. Observe and quantify solar and lunar surface features, including sunspots and craters, to understand their physical properties.

Practical No.	Particulars
1	Study of the Radiation Pattern of the Sun and Estimation of Its Effective Surface Temperature and Luminosity
2	Estimation of First-Order Atmospheric Extinction of Starlight Using Given Data
3	Measurement of Sky Brightness Using a Solid-State Photometer
4	Investigation of the Solar Limb Darkening Effect
5	Determination of the Temperature of an Artificial Star
6	Measurement of the Distance to the Moon Using the Parallax Method
7	Identification and Measurement of Crater Diameters on the Moon's Surface
8	Determination of the Distance to Star Clusters Using the Main Sequence Fitting Method
9	Observation and Measurement of Sunspot Diameters

Learning Resources:

1. Modern Astrophysics – B.W. Carroll and D.A. Ostlie, 1996, Addison-Wesley Publishing Co., Inc.
2. The Physical Universe: An Introduction to Astronomy – Frank H. Shu, 1982, University Science Books, Sausalito, California
3. Astrophysics by Baidyanath Basu
4. Introduction to Astrophysics by K D Abhyankar

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(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: Minor-V

Course Title: Waves and Optics

Course Code: 301PHY6301

Credits: 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objective:

LO 1. The course aims to provide students with a fundamental understanding of the behavior and properties of wave motion, light and interaction of light with matter.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Analyze the principles of wave motion, including superposition, harmonic oscillations, wave propagation, and velocity concepts, to understand mechanical and electromagnetic waves.

CO 2. Apply the principles of surface tension and viscosity to analyze fluid behavior, pressure variations, and flow dynamics in different conditions.

CO 3. Analyze the principles of sound, including vibrations, resonance, and acoustics, to evaluate sound intensity, waveforms, and architectural acoustics.

CO 4. Apply the principles of wave optics, including interference, wavefront propagation, and phase changes, to analyze optical phenomena and light behavior.

Unit No.	Title of Unit & Contents	Hrs.
I	**Wave Motion**	**12**
	1. Introduction 2. Superposition of Two Collinear Harmonic Oscillations: Linearity & Superposition Principle: Oscillations Having Equal Frequencies and Oscillations Having Different Frequencies (Beats). 3. Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and Their Uses. 4. Transverse Waves on a String. 5. Travelling And Standing Waves on a String. 6. Normal Modes of a String. 7. Group Velocity, Phase Velocity. 8. Plane Waves. Spherical Waves, Wave Intensity.	
	Unit Outcomes: UO1. Students will be able to apply the principle of superposition to analyze collinear and perpendicular harmonic oscillations, including beats and Lissajous figures, and interpret their physical significance in wave phenomena. UO2. Students will gain the ability to differentiate between travelling and standing waves, calculate group and phase velocities, and analyze wave intensity for plane and spherical waves, including normal modes of a string.	
II	**Fluids**	**12**

Unit No.	Title of Unit & Contents	Hrs.
	1. Introduction 2. Surface Tension: Synclastic and Anticlastic Surface 3. Excess of Pressure - Application to Spherical and Cylindrical Drops and Bubbles 4. Variation of Surface Tension with Temperature-Jaegar's Method. 5. Viscosity - Rate Flow of Liquid in a Capillary Tube-Poiseuille's Formula 6. Determination of Coefficient of Viscosity of a Liquid-Variations of Viscosity of Liquid with Temperature- Lubrication 7. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to explain the principles of surface tension. UO2. Students will gain the ability to apply Poiseuille's formula to determine the rate of flow of liquids in capillary tubes.	
III	**Sound**	**10**
	1. Introduction 2. Simple Harmonic Motion 3. Forced Vibrations and Resonance 4. Fourier's Theorem-Application to Saw Tooth Wave and Square Wave 5. Intensity And Loudness of Sound 6 Decibels - Intensity Levels-Musical Notes-Musical Scale. 7. Acoustics of Buildings: Reverberation and Time of Reverberation 8. Absorption Coefficient - Sabine's Formula 9. Measurement Of Reverberation Time-Acoustic Aspects of Halls and Auditoria. 10. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to explain simple harmonic motion. UO2. Students will gain the ability to analyze reverberation, calculate reverberation time using Sabine's formula.	
IV	**Wave Optics**	**11**
	1. Introduction 2. Electromagnetic nature of light. 3. Definition and Properties of wave front. Huygens Principle. 4. Interference: Division of amplitude and division of wavefront. 5. Young's Double Slit experiment. 6. Lloyd's Mirror and Fresnel's Biprism. 7. Phase change on reflection: Stokes' treatment. 8. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); 9. Fringes of equal thickness (Fizeau Fringes). 10. Newton's Rings: measurement of wavelength and refractive index. 11. Numerical Problems.	
	Unit Outcomes: UO1. Students will be able to explain the electromagnetic nature of light, Huygens' principle, and analyze interference phenomena. UO2. Students will gain the ability to interpret interference in thin films,	

Unit No.	Title of Unit & Contents	Hrs.
	distinguish between Haidinger and Fizeau fringes.	

Learning Resources:

1. A Text Book of Optics – Brij Lal and Subrahmanyam (S. Chand & Co.)
2. Introduction to Laser Theory and its Applications- M. N. Avadhanulu (S. Chand Publication-2001)
3. B.Sc. Physics Volume-I- C.L. Arora (S. Chand)
4. Lasers and Nonlinear Optics – B.B. Laud (Willey, Eastern Limited)
5. Optics and Atomic Physics – D.P. Khandelwal. (Himalaya Publishing House)
6. Optics (Second Edition) – A.K. Ghatak
7. Geometrical & Physical Optics by D. S. Mathur.
8. A Text Book of Optics – Brij Lal and Subrahmanyam (S. Chand & Co.)
9. Introduction to Laser Theory and its Applications- M. N. Avadhanulu (S. Chand Publication-2001)
10. B.Sc. Physics Volume-I- C.L. Arora (S. Chand)
11. Lasers and Nonlinear Optics – B.B. Laud (Willey, Eastern Limited)
12. Optics and Atomic Physics – D.P. Khandelwal. (Himalaya Publishing House)
13. Optics (Second Edition) – A.K. Ghatak
14. Geometrical & Physical Optics by D. S. Mathur.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science and Technology

Department of Physics and Electronics

Course Type: VSC IV
Course Title: Computational Physics
Course Code: 301PHY6501
Credits: 02 **Max. Marks: 50** **Lectures: 45 Hrs.**

Learning Objectives:

LO 1. This course aims to familiarize the students with the numerical methods used in computation and programming using FORTRAN language to solve physics problems.

LO 2. To impart basic knowledge of computational physics in solving the physics problems.

Course Outcomes:

After completion of the course, students will be able to-

CO 1. Apply basic knowledge of computational physics to solve physics problems.

CO 2. Demonstrate concepts related to variables, I/O, arrays, procedures, modules, and pointers in FORTRAN.

CO 3. Program using FORTRAN or any other high-level language.

CO 4. Use various numerical methods to solve physics problems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Fortran 90**	**7**
	1. Introduction to Fortran_90, 2. Character sets, structure of statements, 3. Structure of a Fortran Program, compiling, linking and executing 4. the Fortran program. 5. Constants & Variables, 6. Arithmetic & Logical Expressions, 7. Arithmetic & Logical operators. 8. Input Output Statements, Conditional Statements, 9. Looping, Functions & Subroutines, 10. Defining and Manipulating Arrays & Strings. 11. Pointers, Data Types & Modules, File Processing.	
	Unit Outcomes: UO1. Students will be able to write, compile, and execute Fortran-90 programs by understanding the structure of statements, constants, variables, arithmetic and logical expressions, and input/output operations. UO2. Students will gain the ability to use conditional statements, loops, functions, subroutines, arrays, strings, pointers, and file processing to solve computational problems and manipulate data effectively	
II	**Numerical Methods**	**8**
	1. Numerical Differentiation 2. Lagrange Interpolation, 3. Numerical integration by Simpson (1/3) rule and Weddle's rules, 4. Numerical solution of differential equations by Taylor's Series,	

	5. Euler Method, 6. Newton-Raphson Method, 7. Runge-Kutta methods, 8. Application of F90 to solve the problems based on these methods.	
	Unit Outcomes: UO1. Students will be able to implement numerical techniques such as differentiation, Lagrange interpolation, and integration (Simpson's 1/3 rule, Weddle's rule) to solve mathematical problems. UO2. Students will gain the ability to use Taylor's series, Euler's method, Newton-Raphson method, and Runge-Kutta methods to numerically solve differential equations, and apply Fortran-90 programming to implement these solutions.	
III	**Practical**	**30**
	Use Fortran 90 programming language to solve the following problems. 1. To find the largest or smallest of a given set of numbers. 2. To find the factorial of a number 3. Transpose of a square matrix using only one array. 4. To obtain the Fibonacci series 5. Find first order derivative at given x for a set of values with the help of Lagrange interpolation. 6. Evaluation of Bessel Functions. 7. To find roots of algebraic equation by Newton-Raphson Method. 8. To solve a Differential Equation by Runge Kutta method. 9. Different equation: Write the differential equation for charging /discharging of a capacitor C through a resistance 'R'. Solve this equation using Euler method. 10. Linear fit / Fitting an exponential/ Fitting a trigonometric function. 11. To perform numerical integration of a function by Simpson's/ Weddle's Rule. 12. Trigonometric Functions Sin(x) and Cos(x) Using Series Method.	

Learning Resources:

1. Programming in Fortran 90 and 95, V. Rajaram, Prentice-Hall of India (2013)
2. Computer Oriented Numerical Methods, V. Rajaraman, Prentice Hall of India (1993)
3. Numerical Methods for Scientist and Engineers, H. M. Antia, Tata McGraw Hill (1991)
4. Numerical Methods with Fortran IV case studies, Dorn & McCracken, John Wiley and Sons (1972)
5. Numerical Recipes in FORTRAN (2nd Edn.), W. H. Press, S. A. Teakalsky, W. T.
6. Vellerling, B. P. Flannery, Cambridge University Press (1997)
7. Computational Physics - An introduction, R. C. Verma, P. K. Ahluwalia, K. C. Sharma,
8. New Age International Publishers (2005).
9. Computational Physics – Fortran Version, S. E. Koonin, D. C. Meredith, Westview Press (1990).

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken English Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/ activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
DSC/DSE/ GE/OE/Minor	100	10	10	20	10	-	-	40	60	100
DSC	75	05	10	15	10	-	-	30	45	75
Lab Course/AIPC/ OJT/FP	50	-	-	-	-	05	20	-	25	50
VSC/SEC/ AEC/VEC/CC	50	05	05	10	05	-	-	20	30	50

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Mark