Shri Sangameshwar Education Society's

Sangameshwar College, Solapur [Autonomous]

(Affiliated to Punyashlok Ahilyadevi Holkar Solapur University, Solapur)

Kannada Linguistic Minority Institute

NAAC Accredited with 'A' Grade (III Cycle CGPA 3.39)

UG Science Program: B.Sc.-III: To be implemented from A.Y. 2022-2023

System: Choice Based Credit System (CBCS) with SGPA and CGPA

B.O.S. in*: Physics

Structure of Choice Based Credit System for Undergraduate Science **Program B.Sc. III (Physics)** to be implemented from **A.Y.2022-2023**

Table-5

Semester	Course		Course Code	Teaching Scheme/week		
				Hours	Lectures	Credits
V	AECC-C	ENGLISH FOR COMMUNICATION-III	223501	3.2	4	2
	DSE-1A	PHYSICS -IX: MATHEMATICAL PHYSICS AND STATISTICAL PHYSICS	2231521	2.4	3	3
		PHYSICS PRACTICAL-IV	2231626	4	5	2
	DSE-2A	PHYSICS -X: SOLID STATE PHYSICS	2231522	2.4	3	3
		PHYSICS PRACTICAL-V	2231627	4	5	2
	DSE-3A	PHYSICS -XI: CLASSICAL MECHANICS	2231523	2.4	3	3
		PHYSICS PRACTICAL-VI	2231628	4	5	2
	ANY ONE from DSE-4A (1) & 4A (2)					
	DSE-4A (1)	PHYSICS -XII: NUCLEAR PHYSICS	2231524	2.4	3	3
		PHYSICS PRACTICAL-VII	2231529	4	5	2
	DSE-4A (2)	PHYSICS -XII: ENERGY STUDIES	2231525	2.4	3	3
		PHYSICS PRACTICAL-VII	2231629	4	5	2
	SGSEC-3	PHYSICS -III: THIN FILM DEPOSITION AND CHARACTERIZATION	2231526	2.4	3	2
	Total			**31.2**	**39**	**24**

VI	AECC-D	ENGLISH FOR COMMUNICATION-IV	2231601	3.2	4	2
	DSE-1B	PHYSICS XIII: ELECTRODYNAMICS	2231621	2.4	3	3
		PHYSICS PRACTICAL-IV	2231626	4	5	2
	DSE-2B	PHYSICS -XIV: MATERIALS SCIENCE	2231622	2.4	3	3
		PHYSICS PRACTICAL-V	2231627	4	5	2
	DSE-3B	PHYSICS -XV: ATOMIC PHYSICS, MOLECULAR PHYSICS AND QUANTUM MECHANICS	2231623	2.4	3	3
		PHYSICS PRACTICAL-VI	2231628	4	5	2
	ANY ONE from DSE-4B (1) & 4B (2)					
	DSE-4B (1)	PHYSICS -XVI: ELECTRONICS	2231624	2.4	3	3
		PHYSICS PRACTICAL-VII	2231629	4	5	2
	DSE-4B (2)	PHYSICS -XVI: INSTRUMENTATION	2231625	2.4	3	3
		PHYSICS PRACTICAL-VII	2231629	4	5	2
	Total			**28.8**	**36**	**22**
Total Semester V and VI				**60**	**75**	**46**

Table-6

Semester	Course		EXAMINATION			Credits
			Marks			
			CA	SEE	Total	
V	AECC-C	ENGLISH FOR COMMUNICATION-III	15	35	50	2
	DSE-1A	PHYSICS -IX: MATHEMATICAL PHYSICS AND STATISTICAL PHYSICS	30	70	100	3
	DSE-2A	PHYSICS -X: SOLID STATE PHYSICS	30	70	100	3
	DSE-3A	PHYSICS -XI: CLASSICAL MECHANICS	30	70	100	3
	ANY ONE from DSE-4A (1) & 4A (2)	PHYSICS -XII: NUCLEAR PHYSICS PHYSICS -XII: ENERGY STUDIES	30	70	100	3
	SEC-3	PHYSICS -III: THIN FILM DEPOSITION AND CHARACTERIZATION	15	35	50	2
	Total		**135+15**	**315+35**	**450+50**	**16**
VI	AECC-D	ENGLISH FOR COMMUNICATION-IV	15	35	50	2
	DSE-1B	PHYSICS -XIII: ELECTRODYNAMICS	30	70	100	3

	DSE-2B	PHYSICS -XIV: MATERIALS SCIENCE	30	70	100	3
	DSE-3B	PHYSICS -XV: ATOMIC PHYSICS, MOLECULAR PHYSICS AND QUANTUM MECHANICS	30	70	100	3
	ANY ONE from DSE-4B (1) & 4B (2)	PHYSICS -XVI: ELECTRONICS PHYSICS -XVI: INSTRUMENTATION	30	70	100	3
	DSE-1A & DSE-1B	PHYSICS PRACTICAL-IV	30	70	100	4
	DSE-2A & DSE-2B	PHYSICS PRACTICAL-V	30	70	100	4
	DSE-3A & DSE-3B	PHYSICS PRACTICAL-VI	30	70	100	4
	DSE-4A & DSE-4B	PHYSICS PRACTICAL-VII	30	70	100	4
		Total	**240+15**	**560+35**	**800+50**	**30**
Total Semester V and VI			**405**	**945**	**1350**	**46**

CA: Continuous Assessment SEE: Semester End Examination

Note: -

The above structure (Table-5 and Table-6) is for Sem-V and Sem-VI of the undergraduate B.Sc.-III programmes* under science faculty.

* B.Sc.-III Chemistry/Physics/Mathematics/Statistics/Electronics/Botany/Zoology.

DSE: Discipline Specific Elective Core Course (When a Student opts a particular course[$] as a principal course from the core courses opted at B.Sc.- II excluding Geography and Psychology).

$ Chemistry/Physics/Mathematics/Statistics/Electronics/Botany/Zoology

AECC: Ability Enhancement Compulsory Course SEC: Skill Enhancement Course

Passing in each course is compulsory. SGPA/CGPA and Total Marks will be calculated excluding AECC courses.

Programmes	Total Marks	Credits
B.Sc.-I	1200+100+50	52
B.Sc.-II	1300+50	56
B.Sc.-III	1250+100	46
Total	**3750+250+50**	**154**

PROGRAM OUTCOMES OF B.Sc. PROGRAM

PO1 Acquire skill, training and knowledge to enhance thinking, comprehension and application abilities to compete, succeed and excel globally**.**

PO2 Gain knowledge and experience (through theory, experiments, tutorials, projects and industrial / field visits), to achieve ultimate progress and improvement, to be capable of employment and meet the global competencies.

PO3 Identify, formulate and analyze problems. Create, select, and apply suitable techniques, resources, and modern scientific tools to accomplish verified conclusions with an understanding of the limitations.

PO4 Apply moral principles, commit to the norms of scientific practice in every endeavor. Validate expertise to conduct wide range of scientific experiments to solve problems.

PO5 Communicate efficiently scientific events with the scientific community and with Society at large with capability to comprehend, pen operative reports, design documentation, make effective presentations, give and receive clear instructions.

PO6 Reveal knowledge with thoughtful expression of the scientific principles in one's own work, as an individual member and capable leader in a team, to manage projects in multidisciplinary environments.

Program Specific Outcomes of B.Sc (Physics) Program

1. Acquire fundamental intelligible understanding of the speculative field of Physics to enhance the ability of micro-observation, deep thinking and analytical skills.
2. Demonstrate the ability to use skills in Physics for formulating and tackling Physics-related problems through patience, intellectual reasoning and problem solving.
3. Apply critical reasoning skills with ethical moralities to solve Physics related problems with precision and accuracy.
4. Demonstrate relevant generic skills and global competencies such as problem-solving skills, investigative skills, communication skills involving, analytical skills, ICT skills; personal skills such as the ability to work both independently and in a group
5. Demonstrate professional behavior such as
    - being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism;
    - the ability to identify the potential ethical issues in work-related situations;
    - Appreciation of intellectual property, environmental and sustainability issues; and promoting safe learning and working environment.

SEM-V

DSC-1A PHYSICS-IX MATHEMATICAL PHYSICS AND STATISTICAL PHYSICS (Course Code: 2231521) (100 Marks and 3 Credits)		**Hours 36hrs.**
Course Objectives: Students should be able to; ● Understand, represent and explain vector theorems & types of differential equations. ● Study, explain and apply orthogonal curvilinear coordinates and its extension. ● Study and state the basic concepts in statistical physics. ● Understand, comprehend and explain the concept of Maxwell Boltzmann Statistics. ● Study and apply Bose Einstein Statistics, Fermi Dirac Statistics.		
Unit 1	Contents: **1. Vector Theorems and Introduction to Partial Differential Equations** **1.1. Scalar and Vector triple products** **1.2. Scalar and Vector fields** **1.3. Del operator** **1.4. Gradient of a Scalar** **1.5. Divergence of a Vector, Curl of Vector and their physical significance** 1.6. Gauss's Theorem 1.7. Green's Theorem 1.8. Stoke's Theorem 1.9. Differential Equations 1.9.1 Types of differential equations 1.9.2 Degree, Order, Linearity, Homogeneity of differential equations 1.9.3 Concept of singular points of differential equations 1.10. Frobenius method of solving differential equations 1.10.1. Legendre differential equation (without solution) 1.10.2. Bessel differential equation (without solution)	07

	1.10.3. Hermite differential equation (with solution) **1.11. Tutorial (Activity on Project based Learning)**	
Unit 2	Contents: **2. Orthogonal Curvilinear Coordinates** 2.1. Introduction to Cartesian, Spherical Polar and Cylindrical Coordinate system 2.2. Concept of Orthogonal Coordinate system 2.3. Gradient in Orthogonal Coordinate system 2.4. Divergence in Orthogonal Coordinate system 2.5. Curl in Orthogonal Coordinate system 2.6 Laplacian Operator in Orthogonal Coordinate system 2.7 Extension of Orthogonal Coordinate system in Cartesian, Spherical polar and Cylindrical Coordinate system **2.8 Tutorial (Activity on Project based Learning)**	07
Unit 3	Contents: **3. Basic Concepts in Statistical Physics** 3.1. Micro and Macro States 3.2. Micro canonical and Canonical Ensemble 3.3. Phase Space 3.4. Accessible microstates 3.5. A Priory Probability 3.6. Thermodynamic Probability 3.7. Probability Distribution 3.8. Entropy and Probability **3.9. Tutorial (Seminar)**	06
Unit 4	Contents: **4. Maxwell Boltzmann Statistics** 4.1. Maxwell Boltzmann Distribution Law 4.2. Evaluation of constants α and β 4.3. Molecular Speeds 4.4. Thermodynamic functions in terms of partition function **4.5. Tutorial**	06

Unit 5	Contents **5. Quantum Statistics - I** 5.1. Bose Einstein Statistics 5.2. Bose Einstein Distribution Law 5.3. Experimental study of black body radiation 5.4. Derivation of Plank's radiation formula 5.6. Deduction of Wein's Formula from Plank's radiation formula 5.7. Deduction of Rayleigh's Jeans Law from Plank's radiation formula 5.8. Deduction of Wein's Displacement Law from Plank's radiation formula 5.9. Stefan's Law from Plank's radiation formula **5.10. Tutorial**	05
Unit 6	Contents: **6. Quantum Statistics - II** 6.1. Fermi Dirac Distribution Law 6.2. Application to free electrons in metals 6.3. Electron energy Distribution 6.4. Fermi Energy 6.5. Comparison of M.B., F.D. and B.E. statistics **6.6. Tutorial**	05

Course Outcomes:

- **Unit 1.** Students will represent, explain and apply vector theorems to differential equation in different applications.
- **Unit 2.** Students will explain orthogonal coordinate system, apply and extend it in to Cartesian, and Spherical polar, cylindrical coordinates.
- Unit 3. Students will study, analyze and apply the statistical concept of Maxwell Boltzmann Statistics, Bose Einstein Statistics, and Fermi Dirac Statistics.
- **Unit 4.** Students will apply Maxwell Boltzmann Statistics, comprehend and apply to evaluate Molecular speeds.
- **Unit 5.** Students will understand and apply the Bose Einstein Statistics and Fermi Dirac Statistics.

Reference Books: -

1. Murray R, Spiegel: Theory and Problems of Vector Analysis: Schaum outline series:

McGraw-Hill Education McGraw-Hill Education

2. George Arfken: Mathematical Methods for Physics: Academic Press, 2013

3. Sharma, Sarkar: Thermodynamics and Statistical Physics: Himalaya Publishing House, 1988

4. J. K. Sharma, K. K. Sarkar: Statistical Mechanics: Himalaya Publishing House, 1988

5. S. Loknathan: Statistical and Thermal Physics: New Delhi: Prentice-Hall of India Private Ltd., 1991.

6. SatyaPrakash, J.P. Agrawal: Statistical Mechanics: Pragati Prakashan

7. Kumar, Gupta: Elementary Statistical Mechanics: PRAGATI PRAKASHAN-MEERUT, 2016

8. Debi Prasad Ray: An Approach to Statistical Physics:

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DSC-2A PHYSICS-X SOLID STATE PHYSICS (Course Code: 2231522) (100 Marks and 3 Credits)		**Hours 36 hrs.**
Course Objectives: Students should be able to; ● Summarize the criteria involved in crystalline and non-crystalline phases of the solids. ● Estimate the correctness of X – ray diffraction to analyze the crystalline materials. ● Interpret free electron theory to metals, electrical & thermal conductivities. ● Interpret the distinction between metals, semiconductors and insulators. ● Justify the magnetism reversal with respect to change in temperature and rephrase the conductivity and superconductivity as one of the marvellous states of matter.		
Unit 1	Contents: **1. Crystallography** 1.1. Lattice and Basis 1.2. Unit cell 1.3. Bravais lattices (2-D, 3-D) 1.4. Inter-planer spacing 1.5. Miller indices 1.6. Packing fraction and co-ordination number for SC, BCC, FCC & HCP structures **1.7. Liquid Crystals**	07

	1.7.1. Smectic Mesophase **1.7.2. Nematic Mesophase** **1.7.3. Cholestric Mesophase** **1.8. Tutorial (Seminar, Activity on Project based learning)**	
Unit 2	Contents: **2. X-ray Diffraction by Crystals** 2.1. Production of X-rays and its properties **2.2. Types of X – rays and its energy** 2.3. Reciprocal Lattice and its properties 2.4. Bragg's law in reciprocal lattice 2.5. Powder method of X-ray diffraction for crystal structure **2.6. Tutorial (Seminar, Activity on Project based learning)**	07
Unit 3	Contents: **3. Free Electron Theory** 3.1. Properties of metals 3.2. Free electron model (Drude and Lorentz model) 3.3. Electrical, Thermal conductivity of metals and Widemann–Franz relation 3.4. Sommerfeld's theory 3.5. Fermi-Dirac distribution 3.6. Fermi energy, degeneracy and non-degeneracy of metals. **3.7. Thermionic Emission** **3.8. Escape of Electrons from a metal** **3.9. Tutorial (Seminar, Activity on Project based Learning)**	06
Unit 4	Contents: **4. Band Theory of Solids** 4.1. Formation of bands in solids (PE, KE and total energy of electron in an isolated atom) 4.2. Formation of energy bands (Valence band, conduction band and forbidden energy gap) 4.3. Motion of electron in one dimensional periodic potential (Kronig-Penney model) 4.4. Effective mass of electron	6

	4.5. Hall Effect and its applications **4.6. Influence of electric field on motion of electron in 1D periodic field** **4.7. Distinction between metals, insulators and Intrinsic semiconductors** **4.8. Direct Experimental Evidence for Band Structure.** **4.9. Tutorial (Seminar, Activity on Project based Learning)**	
Unit 5	Contents **5. Magnetic Materials** 5.1. Magnetic terminology 5.2. Classification of magnetic materials 5.2.1. Diamagnetic materials 5.2.2. Paramagnetic materials 5.1.3. Ferromagnetic materials 5.1.4. Anti-ferromagnetic materials 5.1.5. Ferrimagnetic material and ferrites 5.3. Energy loss in the hysteresis **5.4. Magnetic Resonance** **5.4.1. Nuclear Magnetic Resonance** **5.4.2. Electron Spin Resonance** **5.5. Tutorial (Seminar, Activity on Project based Learning)**	05
Unit 6	Contents: **6. Superconductivity** **6.1. Experimental aspects of Superconductivity** **6.2 Influence of External agents on Superconductivity** **6.3. BCS theory of Superconductivity** **6.3.1. The Electron – Phonon Interaction** **6.3.2. The Cooper pairs** **6.4. Conclusions from BCS theory** 6.5. Type I and type II superconductors 6.6. Critical temperature 6.7. Effect of magnetic field 6.8. Meissner effect 6.9. Josephson effect	05

	6.10. Applications of Superconductivity **6.11. Superconductivity & Concept of Cryo – electronics** **6.12. Tutorial (Seminar, Activity on Project based learning)**	

Course Outcomes:

- **Unit 1.** Students will summarize the crystalline and non-crystalline phases of the solids.
- **Unit 2.** Students will analyze the crystalline materials and reciprocal lattice.
- **Unit 3.** Students will interpret and apply free electron theory to metals to explain the electrical & thermal conductivities.
- **Unit 4.** Students will interpret the distinction between metals, semiconductors and insulators.
- **Unit 5.** Students will recall and justify the magnetism reversal with temperature and rephrase the conductivity and superconductivity as one of the marvelous states of matter.

Reference Books: -

1. Charles Kittel: Introduction to Solid State Physics: Wiley India Edition.
2. S. O. Pillai: Solid State Physics: NEW AGE INTERNATIONAL PUBLISHERS.
3. A. J. Dekker: Solid State Physics: Macmillan Edition.
4. R. K. Puri, V.K. Babbar: Solid State Physics: S. Chand.
5. R. L. Singhal: Solid State Physics: KNRN Publication.
6. B. S Saxena. and R. C. Gupta: Fundamentals of Solid State Physics: Pragati Prakashan.

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DSC-3A PHYSICS-XI CLASSICAL MECHANICS **(Course Code: 2231523) (100 Marks and 3 Credits)**	**Hours** **36 hrs.**

Course Objectives:

Students should be able to;

- Analyze and evaluate the different types of motions of a body under different constraints using Lagrangian formulation.
- Analyze, apply and evaluate the motion of body in different coordinate systems.
- Deduce Lagrange's equations from Hamilton's principle and apply Hamilton's principle.
- Interpret and apply principle of coupled oscillations to frequency and energy of the coupled

oscillatory systems, energy transfer in the coupled oscillatory systems. ● Interpret and apply Euler's theorem, Chassel's theorem and apply to motion of different objects around them.		
Unit 1	Contents: **1. Mechanics of a particle and system of particles** 1.1. Mechanics of a particle using vector algebra and vector calculus 1.2. Conservation theorems for linear momentum, angular momentum and energy of a particle 1.3. Mechanics of a system of particles, concept of centre of mass 1.4. Conservation theorems for linear momentum, angular momentum and energy of a system of particles 1.5. Application of Newton's law of motion - Projectile motion in resistive medium **1.6. Tutorial (Assignments, Activity on Project based Learning)**	07
Unit 2	Contents: **2. Lagrangian Formulation** 2.1. Limitations of Newtonian Formulation 2.2. Introduction of Lagrangian Formulation 2.3. Constraints 2.4. Degrees of freedom 2.5. Generalized coordinates 2.6. Principle of virtual work 2.7. D' Alembert's Principle 2.8. Lagrange's equation from D' Alembert's Principle 2.9. Application of Lagrange's equation to i) A particle in space (Cartesian coordinates) ii) Atwood's Machine and iii) A bead sliding on uniformly rotating wire iv) Simple Pendulum v) Simple harmonic Oscillator **2.10. Tutorial (Assignments, Activity on Project based Learning)**	07
Unit	Contents:	06

3	**3. Moving Coordinate system** 3.1. Moving origin of coordinates 3.2. Pseudo forces 3.3. Rotating coordinate system 3.4. Coriolis force 3.5. Foucault's pendulum 3.6. Effects of Coriolis force in nature 3.7. Effect of Coriolis force on freely falling body **3.8. Tutorial (Assignments, Activity on Project based Learning)**	
Unit 4	Contents: **4. Techniques of Calculus of Variation** 4.1. Hamilton's principle 4.2. Deduction of Lagrange's equations from Hamilton's principle 4.3. Applications: i) Shortest distance between two points in a plane ii) Brachistochrone problem iii) Minimum surface of revolution **4.4. Tutorial (Assignments, Seminar)**	05
Unit 5	Contents **5. Coupled Oscillations** 5.1. Frequencies of coupled oscillatory system 5.2. Normal modes and normal coordinates 5.3. Energy of coupled oscillations 5.4. Energy transfer in coupled oscillatory system **5.5. Reflection Tests**	06
Unit 6	Contents: **6. Motion of rigid body** 6.1. Motion of rigid body in space 6.2. Euler's theorem 6.3. Angular momentum and energy 6.4. Euler's equations of motion **6.5. Tutorial (Assignments, Activity on Project based Learning)**	05

Course Outcomes:

- **Unit 1 & 2.** Students will analyze and evaluate the motion of particles and motion of a body and apply Lagrangian formulation to investigate the different types of motions of a body under different constraints.
- **Unit 3.** Students will analyze, apply and evaluate the motion of body in different coordinate systems.
- **Unit 4.** Students will interpret Hamilton's principle, deduce Lagrange's equations from Hamilton's principle.
- **Unit 5.** Students will interpret and apply principle of coupled oscillations to deduce frequency, energy and energy transfer in the coupled oscillatory systems.
- **Unit 6.** Students will interpret and apply Euler's theorem, Chassel's theorem and apply to the motion of different objects around them.

Reference Books: -

1. Herbert Goldstein: Classical Mechanics: Ms Graw Hill
2. N. C. Rana and P.S. Jog: Classical Mechanics:
3. R. G. Takawale and P.S. Puranic: Introduction to classical Mechanics:
4. Gupta, Kumar and Sharma: Classical Mechanical:
5. P.V. Panat: Classical Mechanics:

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DSE- 4A (1) PHYSICS-XII NUCLEAR PHYSICS **(Course Code: 2231524) (100 Marks and 3 Credits)**	**Hours** **36 hrs.**

Course Objectives:

Students should be able to;

- Define, describe and explain the ground state properties of nucleus and comprehend Liquid Drop Model of Nucleus.
- Define, analyze and evaluate Q-value of nuclear reaction, nuclear reaction cross-section, explain and differentiate Pick-up and Stripping nuclear reactions.
- State and explain the principle of phase stable orbit, principle, construction and working of particle accelerators like Cyclotron and Betatron.

● Classify and explain the principle, construction and working of Geiger-Muller counter, Wilson Cloud Chamber and the Scintillation counter. ● Explain outlines of Pauli Neutrino hypothesis, Beta and Alpha Ray Spectrum, nuclear energy levels from Beta decay. ● Classify and categorize the different properties of elementary particles: leptons, hadrons (baryons and mesons), quarks.		
Unit 1	Contents: **1. Nuclear Structure and Properties** 1.1. Composition of nucleus 1.2. Nuclear radius 1.3. Nuclear spin 1.4. Nuclear magnetic moment 1.5. Electric quadrupole moment 1.6. Mass defect 1.7. Binding energy 1.8. Packing fraction 1.9. Liquid drop model of nucleus **1.10. Nuclear fission Reaction on basis of Liquid Drop model of nucleus** 1.11. Semi-empirical mass formula **1.12. Tutorial (Assignments, Activity on Project based Learning)**	8
Unit 2	Contents: **2. Nuclear Reactions** 2.1. General scheme of nuclear reactions 2.2. Q-value of nuclear reactions 2.3. Threshold energy 2.4. Cross-section of nuclear reactions (Qualitative) 2.5. Stripping reactions 2.6. Pick-up reactions 2.7. Concept of compound and direct Reaction 2.8. Resonance reaction 2.9. Coulomb scattering (Rutherford scattering) **2.10. Tutorial (Assignment)**	05

Unit 3	Contents: **3. Particle Accelerators** 3.1. Need of accelerator 3.2. Cyclotron 3.3. Limitations of cyclotron 3.4. Phase stable orbit 3.5. Betatron **3.6. Tutorial (Activity on Project based Learning)**	06
Unit 4	Contents: **4. Nuclear Radiation Detectors** 4.1. Classification of detectors 4.2. Geiger-Muller counter i. Construction and working ii. Dead time, recovery time and resolving time iii. Self-quenching mechanism 4.3. Wilson Cloud chamber 4.4. Scintillation counter **4.5. Tutorial (Assignment)**	06
Unit 5	Contents **5. Nuclear Energy Levels** **5.1. Alpha decay: basics of α-decay processes, theory of α-emission** **5.2. Gamow factor** **5.3. Geiger Nuttall law** **5.4. α-decay spectroscopy** 5.5. α disintegration energy and **α particle spectra** 5.6. Nuclear energy levels **5.7. Beta decay- Energy Kinematics for β decay** **5.8. Positron emission and Electron capture** 5.9. Experimental study of β decay 5.10. Continuous β - ray spectrum 5.11. Pauli's neutrino hypothesis 5.12. Nuclear energy levels from β decay	06

	5.13. Tutorial (Assignments, Activity on Project based Learning)	
Unit 6	Contents: **6. Elementary particles** 6.1. Introduction of elementary particles 6.2. Types of interactions 6.3. Classification of elementary particles, 6.4. Properties of particles 6.5. Introduction of quarks, 6.6. Different types of quarks. **6.7. Tutorial (Seminar & Activity on Project based learning)**	05

Course Outcomes:

- **Unit 1.** Students will define, describe and explain the ground state properties of nuclei, comprehend Liquid Drop Model of Nucleus.
- **Unit 2.** Students will define, analyze and evaluate Q-value of nuclear reaction, derive and interpret nuclear reaction cross-section, differentiate and explain Pick-up and Stripping nuclear reactions.
- **Unit 3.** Students will appraise the need of a Particle Accelerator, State and explain the principle of phase stable orbit, principle, construction and working of particle accelerators like Cyclotron and Betatron.
- **Unit 4.** Students will classify the detectors of nuclear radiations, state and explain the principle, construction and working of Geiger-Muller counter, Wilson Cloud Chamber and the Scintillation counter.
- **Unit 5.** Students will explain the emission of alpha and beta rays, Pauli Neutrino hypothesis, Beta and Alpha Ray Spectrum nuclear energy levels from Beta decay.
- **Unit 6.** Students will classify and categorize the different properties of elementary particles: leptons, hadrons (baryons and mesons), quarks.

Reference Books: -

1. Irving Kaplan: Nuclear Physics: Addison Wesley
2. S.N. Ghoshal: Nuclear Physics: S. Chand Publishing Co.
3. D.C. Tayal: Nuclear Physics: Himalayan Publishing House
4. J.B. Rajma: Nuclear Physics: S. Chand Publishing Co.
5. Arthur Beiser: Concepts of Modern Physics: Tata McGraw Hill Publishing

6. N. Subrahmanyam & Brijlal: Atomic and Nuclear Physics: S. Chand Pub. Co.
7. B. L. Cohen: Concepts of Nuclear Physics: Tata McGraw Hill Publishing
8. D. Griffith: Introduction to Elementary Particles: John Wiley & Sons.

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DSE-4A (2) PHYSICS-XII ENERGY STUDIES **(Course Code: 2231525) (100 Marks and 3 Credits)**	**Hours** **36 hrs.**

Course Objectives:

Students should be able to;

- Classify, define and explain energy resources, renewable and non-renewable energy sources.
- Appraise and explain Solar energy and Solar energy plant, analyze IV characteristics and Efficiency of photovoltaic cell.
- Appraise and explain Wind energy and Wind energy quantum, wind turbine generator unit. Horizontal Axis Wind Turbine (HAWT) and Wind farm.
- Explain, classify and analyz Direct conversion of biomass, thermochemical conversion of biomass (Pyrolysis) and Biochemical conversion of biomass.
- State and comprehend Ocean energy resources, interpret the guidelines of ocean energy conversion plants and Ocean energy routes.
- Explain energy transport in the atmosphere, Cumulus cloud formation, horizontal motion of air, Geostrophic, origin of pressure difference.

Unit	Contents:	07
1	**1. Energy** 1.1. Forms of energy 1.2. Production of energy 1.3. Energy and environment 1.4. Energy and thermodynamics 1.5. Conventional and non-conventional energy sources 1.6. Energy resources 1.7. Classification of energy resources	

	1.8. Renewable and non-renewable energy sources **1.9. Tutorial (Assignments, Activity on Project based Learning)**	
Unit 2	Contents: **2. Solar Energy** 2.1. Natural effects of Solar energy 2.2 Solar energy plant 2.3 Subsystems in Solar energy plant 2.4 Solar energy chains 2.5 Solar constant, clarity index, Solar insolation 2.6 Solar photovoltaic cell or Solar cell 2.7 Solar photovoltaic systems 2.8 Merits and demerits of solar PV panel system 2.9 IV characteristics of photovoltaic cell 2.10 Efficiency of Solar cell **2.11. Tutorial (Assignment)**	07
Unit 3	Contents: **3. Wind Energy** 3.1. Wind 3.2 Energy chains for wind energy 3.3 Wind energy quantum 3.4 Applications of wind energy 3.5 Wind power density 3.6 Wind turbine 3.7 Efficiency factor of wind turbine (P-H) graph 3.8 Types of wind turbine generator unit 3.9 Horizontal Axis Wind Turbine (HAWT) 3.10 Wind farm **3.11. Tutorial (Activity on Project based Learning)**	07
Unit 4	Contents: **4. Biomass Energy** 4.1. Origin of biomass 4.2 Biomass energy resources	05

	4.3 Biomass conversion processes 4.4 Direct conversion of biomass 4.5 Thermochemical conversion of biomass (Pyrolysis) 4.6 Biochemical conversion of biomass **4.7. Tutorial (Assignment)**	
Unit 5	Contents **5. Ocean Energy** 5.1. Introduction 5.2 Ocean energy resources 5.3 Off shore and on shore ocean energy conversion technologies 5.4 Advantages and limitations of ocean energy conversion technologies 5.5 The guidelines of ocean energy conversion plants 5.6 Ocean energy routes. **5.7. Tutorial (Assignment, Activity on Project based Learning)**	05
Unit 6	Contents: **6. Atmosphere and Energy** 6.1. Introduction 6.2 Energy transport in the atmosphere and to the poles 6.3 Vertical structure of the atmosphere 6.4 Vertical motion of humid air 6.5 The diabetes 6.6 Cumulus cloud formation 6.7 Horizontal motion of air 6.8 Geostrophic flow 6.9 Origin of pressure difference **6.10. Tutorial (Seminar & Activity on Project based learning)**	05

Course Outcomes:

- **Unit 1.** Students will classify, define and explain the different forms of energy, renewable and non-renewable energy sources.
- **Unit 2.** Students will appraise and explain Solar energy, Solar energy plant, explain, interpret IV characteristics and Efficiency of photovoltaic cell.
- **Unit 3.** Students will appraise and explain Wind energy and Wind energy quantum, wind

turbine generator unit, explain Horizontal Axis Wind Turbine (HAWT) and Wind farm.

- **Unit 4.** Students will explain and analyze Direct conversion of biomass, thermochemical conversion of biomass (Pyrolysis) and Biochemical conversion of biomass.
- **Unit 5.** Students will state and comprehend Ocean energy resources, interpret the guidelines of ocean energy conversion plants. Explain Ocean energy routes.
- **Unit 6.** Students will explain energy transport in the atmosphere, Cumulus cloud formation, horizontal motion of air, Geostrophic flow and origin of pressure difference.

Reference Books: -

1. S. Rao, Dr. B.B. Parulekar: Energy Technology:

2. Howard C. Hayden: Energy: A textbook:

3. S. H. Pawar, C.D. Lokhande, R. N. Patil: Solar Energy and Rural Development:

4. Egbert Boeker, Reenk Van Grondelle: Environmental Science (Physical Principals and Applications):

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SEC-3 Thin Film Deposition and Characterization **(Course Code: 2231526) (50 Marks, 2 Credits)**	**Hours** **30 hrs.**

Course Objectives:

- Expose students to the different roles of thin film in day today applications that they experience in daily life.
- Introduce students to various thin film deposition and characterization techniques.
- Help students to experiment, deposit thin film by Chemical Deposition technique like Electrodeposition and SILAR.
- Help students characterize the deposited thin films by XRD, determine the crystal structure and crystallite size from the X-ray diffractogram analysis.
- Guide students to compile the experimental data, analytical data, observations and inferences in the form of research paper.
- Train students to develop the presentation skills and present their research findings in the form of Research Paper Presentation in Conference /Seminar / Workshop / Symposia.

Unit	Contents: **Theory: Credit:1**	06

1	**1. Thin Film Deposition Techniques** 1.1. Introduction 1.2 Role of thin film in various sectors 1.3 Properties and applications of thin films 1.4 Top-down and bottom-up approaches 1.5 Thin film deposition techniques 1.6 Advantages and disadvantages of deposition techniques **1.7. Activity on Project based learning**	
Unit 2	Contents: **2. Chemical Deposition Techniques for Thin Film** 2.1. Introduction 2.2. Chemical bath deposition method (CBD) 2.3. Successive Ionic Layer Adsorption and reaction (SILAR) deposition technique 2.4. Spray Pyrolysis technique 2.5. Sol-Gel technique 2.6. Advantages and Disadvantages of Chemical Deposition techniques over Physical Deposition techniques. **2.7. Activity on Project based learning**	09
Unit 3	Contents: **3. Material selection and substrate cleaning techniques** 3.1. Introduction 3.2 Material selection for various application 3.3 Substrate cleaning equipment and techniques 3.4 Conductive and non-conductive substrate cleaning 3.5 Effect of substrate cleaning in thin film preparation 3.6 Environmental effect on substrate cleaning process **3.7. Activity on Project based learning**	09
Unit 4	Contents: **4. Thin Film Characterization Techniques** 4.1. Introduction 4.2. X-ray diffraction Technique	06

	4.3. Electrical Resistivity 4.4. Water Contact angle 4.5. Scanning Electron Microscopy 4.6. Optical band gap **4.5. Activity on Project based learning**	

Course Outcomes:

- Students will comprehend the different roles of thin films in day today applications.
- Students will investigate various thin film deposition and characterization techniques.
- Students will experiment, deposit thin film by Chemical Deposition technique like Electrodeposition and SILAR.
- Students will characterize the deposited thin films by XRD, determine the crystal structure and crystallite size from the X-ray diffractogram analysis.
- Students will compile the experimental data, analytical data, observations and inferences in the form of research paper.
- Students will develop presentation skills and present their research findings in the form of Research Paper Presentation in Conference /Seminar / Workshop / Symposia.

Reference Books: -

1. S. L. Kakani: Materials Science:
2. R.S. Khurmi, S. Chand: Materials Science:
3. Sulbha Kulkarni: Nanotechnology: Principals and practices: Capital Publishing Co. New Delhi.
4. Krishna Seshan: Hand book of thin film deposition processes and techniques.

SEM-VI

DSC-1B PHYSICS-XIII ELECTRODYNAMICS **(Course Code: 2231621) (100 Marks and 3 Credits)**	**Hours** **45 hrs.**

Course Objectives:

Students should be able to;

- Deduce and explain Poisson's and Laplace's equations, apply to interpret motion of charged particle in constant electric (E) field, in constant magnetic (B) field, both crossed uniform

electric and magnetic fields.

- State and deduce Integral & Differential forms of Faraday's laws, apply to self-inductance to solenoid and mutual inductance to transformer.
- Interpret Maxwell's correction to Ampere's law and deduce Maxwell's equations for time dependent electric and magnetic fields in vacuum, material medium, interpret Physical significance (Integral form) of Maxwell's Equations.
- Interpret and prove Poynting's theorem, deduce and interpret Plane E. M. waves in dielectric, conductors, Attenuation of wave in metal (skin depth).
- Deduce and explain Reflection and refraction of E. M. waves at a boundary of two dielectrics, Reflection from a conducting plane – normal incidence, explain and interpret Total reflection.
- Define and deduce Retarded time and retarded potential and Electric dipole radiation, derive Radiation reaction for electric dipole.

Unit 1	Contents: **1. Electrostatics and Charged particle dynamics** **1.1. Electric Field in matter** **1.2. Polarization and Polarization Charges** **1.3. Electrical Susceptibility and Dielectric Constant** **1.4. Displacement vector D. Relations between E, P and D.** **1.5. Gauss Law in dielectrics.** 1.6. Coulomb's law 1.7. Gauss law in differential form 1.8. Poisson's and Laplace's equations 1.9. Applications of Poisson's and Laplace's equation to spherical systems 1.10. Motion of charged particle in constant electric (E) field 1.11. Motion of charged particle in constant magnetic (B) field 1.12. Motion of charged particle in constant crossed uniform electric and magnetic fields **1.13. Tutorial (Seminar, Activity on Project based learning)**	8
Unit 2	Contents: **2. Time varying fields** 2.1. Electromotive force 2.2 Electromagnetic induction -Faraday's laws	06

	2.3 Lenz's law 2.4 Integral & Differential forms of Faraday's laws 2.5 Self inductance 2.6 Application of self-inductance to solenoid 2.7 Mutual inductance 2.8 Application of mutual inductance to transformer **2.9 Tutorial (Seminar, Activity on Project based learning)**	
Unit 3	Contents: **3. Maxwell's equations** 3.1. Magnetization vector (M). Magnetic Intensity (H) 3.2. Magnetic Susceptibility and Permeability 3.3. Relation between B, H, M. 3.4. Biot – Savart law 3.5. Derivation of $\nabla . \vec{B} = 0$ 3.6. Energy stored in a Magnetic Field 3.7. Ampere's law 3.8. Derivation of $\nabla \times \vec{B} = \mu_0 J$ or Differential form of Ampere's law 3.9. Equation of continuity 3.10. Displacement current density 3.11. Maxwell's correction to Ampere's law 3.12. Maxwell's equations for time dependent electric and magnetic fields in vacuum 3.13. Maxwell's equations for time dependent electric and magnetic fields in dielectrics 3.14. Maxwell's equations for time dependent electric and magnetic fields in material medium 3.15. Physical significance (Integral form) of Maxwell's Equations **3.16. Tutorial (Activity on Project based learning)**	06

Unit 4	Contents: **4. Electromagnetic waves** 4.1. Conservation of energy in electromagnetic fields and Poynting's theorem 4.2. Conservation of momentum in electromagnetic fields 4.3. Wave equations for electric and magnetic fields in vacuum 4.4. Plane wave solutions, orthogonality of $\vec{E}$, $\vec{B}$ and propagation vector $\vec{k}$ 4.5. Plane E. M. waves in dielectric 4.6. Plane E. M. waves in conductors, Attenuation of wave in metal (skin depth) **4.7. Tutorial (Activity on Project based learning)**	06
Unit 5	Contents **5. Reflection and Refraction of E.M. waves** 5.1. Boundary conditions for E. M. field vectors ($\vec{D}$, $\vec{B}$, $\vec{E}$ & $\vec{H}$) 5.2. Reflection and refraction of E. M. waves at a boundary of two dielectrics (Normal incidence only) 5.3. Reflection from a conducting plane – normal incidence 5.4. Total Internal reflection. **5.5. Tutorial (Activity on Project based learning)**	05
Unit 6	Contents: **6. Radiation from Electric Dipole** 6.1. Electric dipole 6.2. Retarded time and retarded potential 6.3. Electric dipole radiation 6.4. Radiation reaction for electric dipole **6.5. Tutorial (Activity on Project based learning)**	05

Course Outcomes:

- **Unit 1.** Students will explain motion of charged particle in constant electric (E) field, in constant magnetic (B) field, both crossed uniform electric and magnetic fields.
- **Unit 2.** Students will state and deduce Integral & Differential forms of Faraday's laws, self-inductance of solenoid and mutual inductance to transformer.
- **Unit 3.** Students will interpret Maxwell's correction to Ampere's law and deduce Maxwell's equations for time dependent electric and magnetic fields in vacuum, material medium,

interpret Physical significance (Integral form) of Maxwell's Equations.

- **Unit 4.** Students will interpret and prove Poynting's theorem, deduce Plane E. M. waves in dielectric and Plane E. M. waves in conductors, Attenuation of wave in metal (skin depth).
- **Unit 5.** Students will explain Reflection and refraction of E. M. waves at a boundary of two dielectrics, Reflection from a conducting plane – normal incidence, Total internal reflection.
- **Unit 6.** Students will derive Radiation reaction for electric dipole.

Reference Books: -

1. David J. Griffiths: Introduction to Electrodynamics (second edition-July 1989): PHI Pvt. Ltd.
2. David J. Griffiths Introduction to Electrodynamics (third edition- 1999): PHI Pvt. Ltd.
3. J. D. Jackson Classical Electrodynamics: John Wiley & Sons
4. S. P. Puri Classical Electrodynamics: Alpha Science International Limited, 2011
5. B. B. Laud: Electrodynamics: New Age International Pvt Ltd
6. Reitz and Milford: Foundations of Electromagnetic Theory
7. R. A. Barapte: Electromagnetic Engineering: TECHNOVA Educational Publications, Pune.

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DSC-2B PHYSICS-XIV MATERIALS SCIENCE (Course Code: 2231622) (100 Marks and 3 Credits)	**Hours 36 hrs.**

Course Objectives:

Students should be able to;

- Analyze properties of the materials apply to the phenomenon of luminescence, explain polymers and polymerizations.
- Interpret the configuration of ceramic materials and different types of bonds involved in the formation of ceramics.
- Design a new material with combined properties of different materials.
- Apply the biomechanisms and other biological process useful in the formation of bio – materials.
- Evaluate the prerequisites of materials at the level of billionth of meter, analyze physico-chemical properties of the materials, generalize the synthesis of materials & predict productive applications.

Unit 1	Contents: **1. Materials and their properties:** 1.1. **Levels & Structure (a) Macrostructure, (b) Microstructure, (c) Substructure, (d) crystal Structure, (d) electronic structure, (e) Nuclear Structure.** 1.2. **Structure – Property relationship** 1.3. Classification of materials, Organic, Inorganic and Biological materials 1.4. Properties of materials (a) Mechanical properties, (b) Thermal properties, (c) Optical properties, (d) Electrical properties, (e) Magnetic properties **1.4. Luminescence:** **1.4.1. Photoluminescence** **1.4.2. Phosphors** **1.4.3. Cathodoluminescence** **1.4.4. Electroluminescence** **1.4.5. Applications** **1.5. Material Selection for Scientific / Engineering applications** **1.6. Tutorial (Seminar, Activity based on Project based learning)**	8
Unit 2	Contents: **2. Polymer materials:** 2.1 Polymers 2.2 Polymerization mechanism 2.2.1 Additional polymerization 2.2.2 Condensation polymerization 2.2.3 Homo-polymer 2.2.4 Co-polymer 2.3 Degree of polymerization 2.4 Defects in the polymers 2.5 Mechanical properties of polymers, deformation, reinforced polymers 2.6 Applications of polymers. **2.7. Tutorial (Seminar, Activity on Project based learning)**	06

Unit 3	Contents: **3. Ceramic Materials:** 3.1 Classification of ceramic materials 3.2 Structure of ceramics 3.3 Ceramic possessing 3.4 Properties of Ceramics 3.5 Applications of Ceramics **3.6. Tutorial (Seminar, Activity on Project based learning)**	06
Unit 4	Contents: **4. Composite Materials:** 4.1 Fabrication of composites 4.2 Mechanical properties of composites 4.3 Particle-Reinforced Composites 4.4 Fibre – Reinforced composites 4.5 Applications of composites **4.6. Tutorial (Seminar, Activity on Project based learning)**	05
Unit 5	Contents **5. Biomaterials:** 5.1 Bio-Mechanism 5.2 Classification of Biomaterials 5.3 Processing of Biomaterials 5.4 Properties of Biomaterials 5.5 Applications of Biomaterials **5.6. Tutorial (Seminar, Activity on Project based learning)**	05
Unit 6	Contents: **6. Nanomaterials:** 6.1 Introduction to nano-sized materials and structures 6.2 Brief history of nanomaterials and challenges in nanotechnology 6.3 Significance of nano-size and properties 6.4 Classification of nano structured materials 6.5 Methods of synthesis of nanomaterials	06

	6.5.1 Bottom-up and Top-down approaches **6.5.2. Epitaxial techniques: (a) Molecular beam epitaxy, (b) Metal organic vapour phase epitaxy, (c) Liquid phase epitaxy.** **6.5.3. Physical methods: High energy ball milling, Physical vapours deposition, sputter deposition, Ultrasonic spray pyrolysis etc.** **6.5.4. Chemical methods: colloidal method, co-precipitation and sol-gel method** **6.5.5. Hybrid method: Electrochemical and chemical vapours deposition.** **6.6. Nanotechnology and Environment** **6.7. Tutorial (Seminar, Activity on Project based learning)**	

Course Outcomes:

- **Unit 1. & 2.** Students will analyze the connectivity between different properties of the materials and apply to phenomenon of luminescence and explain polymers and polymerizations.
- **Unit 3.** Students will interpret the configuration of ceramic materials and explain different types of bonds involved in the formation of ceramics.
- **Unit 4.** Students will design a new material with combined properties of different materials and extend to manufacturing of materials.
- **Unit 5.** Students will apply the biomechanisms and other biological process useful in the formation of bio-materials.
- **Unit 6.** Students will evaluate the prerequisites of materials at the level of billionth of meter. Analyze physico-chemical properties of the materials, discover the applications of materials synthesis & productive applications.

Reference Books: -

1. S. L. Kakani, Amit Kakani: Material Science: New Age International Publishers.

2. V. Raghavan: Materials Science and Engineering: 5th edition, PHI

3. R. S. Khurmi Materials Science: S. Chand

4. G.K. Narula, K.S. Narula, V.K. Gupta: Materials Science: Tata McGraw-Hill.

5. Thomas Varghese & K.M. Balakrishna Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials: Atlantic publication

6. V. Rajendran & A. Marikani: Materials Science: (TMHl).

7. Sulbha Kulkarni: Nanotechnology: Principles and Practices: Capital Publishing Co. New Delhi.

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DSC-3B PHYSICS-XV ATOMIC PHYSICS, MOLECULAR PHYSICS AND QUANTUM MECHANICS (Course Code: 2231623) (100 Marks and 3 Credits)		**Hours 36 hrs.**
Course Objectives: Students should be able to; ● Analyze and interpret Alkali Spectra, spectra doublet fine structure of alkali metals, analyze spectrum of Sodium, intensity rules. ● Explain Anomalous Zeeman effect, apply it to illustrate Paschen Back effect and Stark effect of hydrogen in strong and weak magnetic and electric field. ● Analyze, apply and explain vibrational energy levels and vibrational spectra, electronic spectra of a diatomic molecule, Franck-Condon principle, Raman effect. ● Set up time dependent and time independent Schrödinger wave equations, deduce probability current density, Particle in a Box, Step Potential, Potential Barrier, Linear Harmonics Oscillator, Zero-point energy. ● Use the Operators to determine Eigen values of Hydrogen atom using Schrodinger's equation.		
Unit 1	Contents: **1. Atomic Spectra** 1.1. Review of quantum numbers 1.2. Electronic configuration of alkali metals 1.3. Spectral notations with examples 1.4. Alkali spectra 1.5. Doublet fine structure of alkali metals 1.6. Spectrum of Sodium 1.7. Selection rules 1.8. Intensity rules **1.9. Tutorial (Seminar, Assignment)**	07

Unit 2	Contents: **2. Effects of Magnetic and Electric fields on Atomic Spectra** 2.1. Anomalous Zeeman effect and its explanation from vector atom model 2.2. Paschen Back effect 2.3. Paschen Back effect in principal series doublet 2.4. Selection rules for Paschen Back effect 2.5. Stark effect of hydrogen 2.6. Weak field Stark effect in hydrogen 2.7. Strong field Stark effect in hydrogen **2.8. Tutorial (Assignment)**	07
Unit 3	Contents: **3. Molecular Spectra and Raman Effect** 3.1. Molecular bond 3.2. Rotational energy levels and Rotational spectra 3.3. Vibrational energy levels and Vibrational spectra 3.4. Vibration-Rotation spectra 3.5. Electronic spectra of a diatomic molecule 3.6. Franck-Condon principle 3.7. Raman effect 3.8. Characteristic properties of Raman lines 3.9. Classical theory of Raman effect 4.0. **Infra-Red (IR) Spectroscopy: Principle, Construction and working of IR Spectrophotometer.** **4.1. Absorption equation** **4.2. Tutorial (Seminar, Activity based on Project based learning)**	07
Unit 4	Contents: **4. Quantum Mechanics** 4.1. Heisenberg's uncertainty principle (Statement) and its similarity with concept of matter waves 4.2. Physical significance of ψ 4.3. Time dependent and time independent Schrödinger wave equations 4.4. Eigen values and Eigen functions	05

	4.5. Probability current density **4.6. Tutorial (Seminar, Activity based on Project based learning)**	
Unit 5	Contents **5. Application of Schrodinger's time independent wave equation** 5.1. Particle in a Box (one- and three-dimensional cases), its Eigen values and Eigen functions. 5.2. Step Potential (Statement, boundary conditions, Schrodinger's equations in different regions and discussion of results) 5.3. Potential Barrier (Statement, boundary conditions, Schrodinger's equations indifferent regions and discussion of results) 5.4. Potential Well (Statement, boundary conditions, Schrodinger's equations in different regions and discussion of results) 5.5. Linear Harmonics Oscillator – Eigen values and Eigen functions 5.6. Zero-point energy **5.7. Tutorial (Assignment)**	05
Unit 6	Contents: **6. Operators** 6.1. Operators in Quantum Mechanics 6.2. Expectation values and properties 6.3. Angular momentum operators 6.4. Commutation properties for components Lx, Ly, Lz 6.5. Commutation for L^2 and Lz operators and their Eigen values 6.6. Schrodinger's equation for hydrogen atom 6.7. Separation of radial and angular parts **6.8. Tutorial (Assignment)**	05

Course Outcomes:

- **Unit 1.** Students will interpret atomic spectra, doublet fine structure of alkali metals, analyse spectrum of Sodium, intensity rules.
- **Unit 2.** Students will explain Anomalous Zeeman effect, apply to illustrate Paschen Back effect and Stark effect of hydrogen in strong and weak magnetic and electric field.
- **Unit 3.** Students will analyze and explain vibrational energy levels and vibrational spectra, electronic spectra of a diatomic molecule, Franck-Condon principle, Raman effect.

- **Unit 4. & 5.** Students will set up time dependent and time independent Schrödinger wave equation, deduce probability current density, Particle in a Box, Step Potential, Potential Barrier, Linear Harmonics Oscillator, Zero-point energy.
- **Unit 6.** Students will use the Operators to determine Eigen values of Hydrogen atom using Schrodinger's equation.

Reference Books: -

1. H. E. White: Atomic Spectra: Mc Graw Hill Publication
2. Banwell: Molecular Spectroscopy: Mc Graw Hill Publication
3. Hertzberg: Molecular Spectroscopy: ACS Publication
4. Mathews and Venkateshan: Quantum Mechanics:
5. Pauling and Wilson: Introduction to Quantum Mechanics:
6. Kamal Singh and S.P. Singh: Elements of Quantum Mechanics:
7. Arthur Beiser: Perspectives of Modern Physics:
8. Chatwal Anand: Quantum Mechanics:
9. S. Rajasekar, R. Velusamy Quantum Mechanics: I The Fundamentals:

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DSE-4B(I) PHYSICS -XVI ELECTRONICS **(Course Code: 2231624) (100 Marks and 3 Credits)**		**Hours** **36 hrs.**
Course Objectives: Student should be able to; ● Use Op-amp for different applications, comprehend, design different projects using op-amp. ● Use IC-555 timer in circuits in modes of operation, design different timer circuits. ● Use DIAC, TRIAC and SCR to design circuits for different applications. ● Analyze the display mechanism of different display devices around them. ● Comprehend the theory, mechanism and different applications of Opto-electronic devices for different applications.		
Unit 1	Contents: **1. Operational Amplifier:** 1.1. Block diagram of OP-AMP	07

	1.2. Characteristics of OP-AMP 1.3. OP-AMP parameters 1.4. OP-AMP as inverting amplifier 1.5. OP- AMP as non- inverting amplifier 1.6. Applications of OP-AMP 1.6.1. Adder 1.6.2. Subtractor 1.6.3. Differentiator 1.6.4. Integrator 1.6.5. Comparator 1.6.6. Schmitt's trigger **1.7. Tutorial (Assignment)**	
Unit 2	Contents: **2. Timer** 2.1. Functional Block diagram of IC 555, its Pin connections 2.2. Operating modes 2.2.1 Monostable 2.2.2 Astable 2.3. Applications of timer IC 555 2.3.1. Linear ramp generator 2.3.2. Square wave generator 2.3.3. Voltage to frequency converter **2.4. Tutorial (Assignment, Activity on Project based learning)**	07
Unit 3	Contents: **3. Silicon Controlled Rectifier (SCR)** 3.1. Four-layer PNPN diode 3.2. SCR construction and working 3.3. Characteristics of SCR 3.4. Turn ON and Turn OFF methods of SCR 3.5. Applications of SCR to control the speed of DC motor **3.6. Mind-mapping, Assignment**	07

Unit 4	Contents: **4. Diac and Triac** 4.1. Construction, working and characteristics of Diac 4.2. Applications of Diac 4.2.1. Lamp dimmer 4.2.2. Heat control 4.3. Construction, working and characteristics of Triac 4.4. Applications of Triac 4.4.1 High power lamp switch 4.4.2 Electronic change over power transformer **4.5. Seminar, Assignment**	05
Unit 5	Contents **5. Display Devices** 5.1. Classification of Displays 5.2. Light emitting Diode displays 5.3. Liquid Crystal Displays and its Important Features 5.4. Other displays 5.4.1. Gas Discharge plasma Displays 5.4.2. Electrophoretic Image Displays (EPID) 5.4.3. Liquid Vapour Display (LVD) **5.5. Assignment, Activity on Project based learning**	05
Unit 6	Contents: **6. Opto-electronic Devices** 6.1. **Introduction** 6.2. **Light** 6.3. **Nature of light** 6.4. **Wave nature of light** 6.5. **Light sources blackbody radiation** 6.6. **Units of light** 6.7. **Photo-detectors-introduction** 6.8. **Thermal detectors** **6.8.1. Thermoelectric detectors** **6.8.2. The Bolometer** 6.9. **Photon devices** **6.9.1. Photo emissive devices**	05

	6.9.2. Vacuum photodiodes 6.10. **Optical disk** 6.11. **Tutorial/Online activity/Assignment**	

Course Outcomes:

- **Unit 1.** Student will design different projects using Op-amp.
- **Unit 2.** Student will design different timer circuits IC-555.
- **Unit 3. & 4.** Student will design circuits for different applications using DIAC, TRIAC and SCR.
- **Unit 5.** Student will analyze the display mechanism of different display devices around them.
- **Unit 6.** Student will comprehend the theory, mechanism and different applications of Opto-electronic devices for different applications.

Reference Books: -

1. Grob: Basic Electronic: Mc Graw Hill Publication
2. V.K. Mehta: Principles of Electronics: S Chand and Co. Ltd.
3. Ramakant Gayakwad: Op-Amps and linear Integrated Circuits: 4th edition:
4. B. L. Theraja, A.K. Theraja: A Text book of Electrical Technology Vol. IV:
5. Malvino and Leach: Digital Principles and Application: Mc Graw Hill Publication 4th edition.
6. Allan Mottershed: Electronic Circuits and Devices:
7. H. S. Kalsi: Electronic Instrumentation: Macgrow Hill 1987.

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DSE-4B (2) PHYSICS-XVI INSTRUMENTATION (Course Code: 2231625) (100 Marks and 3 Credits)	**Hours 36 hrs.**

Course Objectives:

Student will be able to;

- Classify, design circuits using transducers in various applications.
- Explain the different types of Microscopes, construction and working and illustrate their applications.
- Describe the application of UV and IR spectroscopy, XPS, Raman Spectroscopy, explain their significance and applications.
- Classify Transducer, illustrate their characteristics, design circuits using transducers in

	various applications. ● State and explain the Principle, Construction and working of X-ray diffractometer, illustrate various application of X-ray diffraction and X-ray Fluorescence. ● Explain the Principle, Construction and working of Mossbauer spectrometer, explain the applications of Mossbauer Spectroscopy. ● Explain the Principle, Construction and working of ECG, EEG, MRI and explain their applications.	
Unit 1	Contents: **1. Transducers and Sensors** 1.1. Transducers and Sensors (Working principle, efficiency, applications) 1.2. Active and passive transducers. 1.3. Characteristics of Transducers. 1.4. Transducers as electrical element and their signal conditioning. 1.5. Temperature transducers: RTD, 1.6. Thermistor. 1.7. Position transducer: Strain gauge, piezoelectric transducer. 1.8. Inductance transducer: Linear variable differential transformer (LVDT), 1.9. Capacitance transducer. 1.10. Magneto-resistive transducer. 1.11. Sensor‑ Dry reed relay 1.12. Servomotor sensors **1.13. Tutorial (Seminar, Activity on Project based learning)**	07
Unit 2	Contents: **2. Characterization techniques-I (Electron Microscopy)** 2.1. Resolution and Magnification of Electron microscope 2.2. Construction, working of SEM 2.3. Application of SEM 2.4. Construction and working of TEM 2.5. Application of TEM 2.6. Difference between optical and electron microscopy. **2.7. Tutorial (Seminar, Activity on Project based learning)**	07
Unit 3	Contents: **3. Characterization techniques-II (Spectroscopic techniques)**	07

	3.1. UV‑Visible spectroscopy 3.1.1. Principle 3.1.2. Construction and working of ultra‑visible (UV) spectrophotometer 3.1.3. Application of UV‑Visible spectroscopy 3.2. Infra- Red (IR) Spectroscopy 3.2.1. Principle 3.2.2. Construction and working of IR spectrophotometer 3.2.3. Application of IR spectroscopy 3.3. Raman spectroscopy 3.3.1. Principle 3.3.2. Construction and working of Raman Spectrometer 3.3.3. Application of Raman Spectroscopy 3.4. X-ray photoemission spectroscopy (XPS) 3.4.1. Principle 3.4.2. Construction and working of X-ray photoemission Spectrometer 3.4.3. Application of XPS. **3.5. Tutorial (Seminar, Assignment)**	
Unit 4	Contents: **4. X-ray Diffraction** 4.1. Principle 4.2. Construction and working of X-ray diffractometer 4.3. Application of X-ray diffraction. 4.4. X-ray Fluorescence (XRF). **4.5. Tutorial (Seminar, Activity on Project based learning)**	05
Unit 5	Contents **5. Mossbauer Spectroscopy** 5.1. Principle 5.2. Construction and working of Mossbauer spectrometer 5.3. Application of Mossbauer Spectroscopy. **5.4. Tutorial (Assignment)**	05
Unit 6	Contents: **6. Bio-medical Instruments**	05

	6.1. Electro Cardio Gram (ECG) 6.1.1. Principle 6.1.2. Construction and working of ECG 6.1.3. Application of ECG. 6.2. Electro Encephala Graph (EEG) 6.2.1. Principle 6.2.2. Construction and working of EEG 6.3.3. Application of ECG. 6.3. Magnetic Resonance Imaging (MRI) 6.3.1. Principle 6.3.2. Construction and working of MRI 6.3.3. Application of MRI. **6.4. Tutorial (Activity on Project based learning)**	

Course Outcomes:

Unit 1. Students will classify, illustrate and design circuits using transducers in various applications

Unit 2. Students will explain the different types of Microscopes, construction and working and illustrate their applications.

Unit 3. Students will describe the application of UV and IR spectroscopy, XPS, Raman Spectroscopy, explain their significance and applications.

Unit 4. Students will state and explain the Principle, Construction and working of X-ray diffractometer, illustrate various application of X-ray diffraction and X-ray Fluorescence.

Unit 5. Students will explain the Principle, Construction and working of Mossbauer spectrometer, explain the applications of Mossbauer Spectroscopy.

Unit 6. Students will explain the Principle, Construction and working of ECG, EEG, MRI and explain their applications.

Reference Books: -

1. H. S. Kalsi: Electronic Instrumentation: Macgraw Hill 1987.
2. R.S. Khandpur, Raghbir Khandpur: Handbook of Biomedical Instrumentation: TATA Mc Grow Hill Education 2014
3. M. L. Cromwell: Biomedical Instruments and Measurements: Prentice Hall
4. Barbara Christ: Introduction to Biomedical Instruments: Cambridge

5. Colin N. Banwell & E. M. McCash: Fundamentals of Molecular Spectroscopy: 4th Edition.
6. B. L. Thereja: Basic Electronics Solid State: S. Chand and Co. Ltd.
7. Rangan, Sarma, Mani: Instrumentation Devices and System: Tata Mc Graw Hill.

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B. Sc-III Practical Evaluation Pattern

(New CBCS Semester Pattern Syllabus with effect from 2022-23)

- **Physics Practical IV, V, VI & VII are divided in to 4 groups.**

Part I: Practical CA: 120 marks

- **Assessment of Practical Course CA per group: Total 120 marks**

One experiment from each group + 2 minor Research Project
= (20x4) + (20x2) = 80 + 40 = **120 marks**

Part II: Practical SEE: 140 marks

- **Assessment of Practical Course SEE per group: Total 140 marks**

One experiment from each Group (I to IV) experiments SEE (35x4) = 140 marks

Part III: Submissions: 140 marks

Major Scientific Project: 70 marks

Journal: 30 marks

Seminar: 20 marks

Study Tour/Industrial Visit: 20 marks

Total: **140 marks**

The entire Practical mark distribution will be as under:

Part I: CA: **120 marks**

Part II: SEE 4 experiment performance: 140 marks

Part III: Submissions: **140 marks**

Total Practical Examination marks: **400 marks**

Details of mark distribution of submissions:

- **Major Scientific Project: [70 marks]**
  - Theme of the Project: 05 marks
  - Data collection: 05 marks
  - Applicability: 05 marks
  - Workability / Success of Project 05 marks
  - Report writing skill: 20 marks
  - Participation/Presentation
    In Conference/Seminar/Workshop 10 marks
  - Visit to concerned Industry/ Institute 10 marks
  - Power Point Presentation of Report 10 marks
    Total: **70 marks**

- **Certified Journal: [30 marks]**
  - Neatness: 10 marks
  - Punctuality: 10 marks
  - Completion: 10 marks
  - **Total:** **30 marks**

- **No marks will be given for uncertified Journal**

- **Seminar Report: [20 marks]**
  - Subject content: 05 marks
  - Accuracy/Fluency
    in content presentation: 05 marks
  - Confidence/stage daring: 05 marks

- Interaction skill: 05 marks
- **Total:** **20 marks**

- **Study Tour/Industrial Visit: [20 marks]**
  - Report writing skill: 05 marks
  - Interaction Skill: 05 marks
  - Tour Report 10 marks
  - **Total:** **20 marks**
- **No marks will be given for absence in Study Tour/Industrial Visit.**

The distribution of Practical in different groups is as under:

DSE- 1A & 1B PHYSICS PRACTICAL - IV	
Experiment No.	**Group-I: GENERAL PHYSICS, HEAT AND SOUND (Course Code: 2231626)**
1	S.T. of a Soap film
2	S.T. by Ferguson's modified method
3	S.T. by ripple method
4	Y and η using Flat Spiral Spring
5	Y by Koenig's method
6	Stefan's fourth power law
7	Thermal conductivity by Lee's method
8	Velocity of sound by CRO
9	Thermocouple: To study See-beck and Peltier effect
10	Resonating Pendulum

DSE- 2A & 2B PHYSICS PRACTICAL-V	
Experiment No.	**Group – II: OPTICS (Course Code: 2231627)**
1	Cardinal points by Newton's method
2	Lloyd's single mirror
3	Transverse and spherical aberration of thick lens

4	Diameter of a Lycopodium powder
5	Diffraction at cylindrical obstacle
6	Elliptically and Circularly polarized light
7	Diffraction due to straight edge.
8	Dispersive Power of grating
9	Resolving Power of Prism
10	Divergence of LASER beam

DSE- 3A & 3B PHYSICS PRACTICAL -VI	
Experiment No.	**Group – III: ELECTRICITY AND MAGNETISM (Course Code: 2231628)**
1	Crystallography, study of XRD pattern & Miller Indices
2	Self- inductance by Owen's bridge
3	High resistance by method of leakage
4	Thin Film preparation by any Chemical method
5	Determination of Stopping potential of Solar Cell
6	Measurement of B_H, B_V and q using Earth Inductor
7	Calibration of bridge wire by Carey Foster's bridge method.
8	Absolute capacitance of condenser by BG method.
9	Hysteresis by CRO
10	Determination of Dielectric constant & unknown Capacitance of Capacitor

DSE- 4A & 4B PHYSICS PRACTICAL -VII	
Experiment No.	**Group – IV: NUCLEAR PHYSICS, OPTOELECTRONICS & ELECTRONICS (Course code: 2231629)**
1	Estimation of Efficiency of GM Counter
2	Determination of range and maximum energy of Beta particle
3	IV-Characteristics of different colored LEDs

4	IV-Characteristics of Photo diode
5	IV-Characteristics of Phototransistor (or LDR characteristics).
6	Comparative study of IV-characteristics of LED and p n-junction diode
7	Data transmission using LASER.
8	IR detection.
9	Astable Multivibrator using IC555
10	Study of Mono-stable operation of IC 555
11	OP-AMP Parameters
12	OP-AMP as inverting amplifier
13	OP-AMP as comparator –Schmitt's trigger
14	FET as VVR
15	RS and JK flip flops
16	Minor Research Project on Coin experiment
17	Minor Research Project on Contact Angle

DSE- 4A & 4B PHYSICS PRACTICAL - VII	
Experiment No.	**Group – IV: ENERGY STUDIES & INSTRUMENTATION**
1	To study photo response of given solar cell.
2	To study the current-voltage characteristic of solar cell under illumination.
3	Study of sensible heat storage using liquid.
4	Thermal efficiency of liquid – flat plate collector.
5	Study of box type solar cooker.
6	Determination of instantaneous thermal efficiency of parabolic collector.
7	Study IR, UV and XPS pattern of the material.
8	Determination of Crystal structure by XRD and study of microstructure by SEM/TEM pattern.
9	Study of ECG/EEG/MRI pattern
10	Study of Mossbauer XPS Pattern
11	Temperature sensor: NTCR/PTCR

12	LDR

Teaching-Learning Equipment/Tools/Methods/etc.:

- Laboratory setup as per requirement of instruments and apparatus for each experiment.
- Experimental method.

Reference Books: -

1. Michael Nelkon and Jon Ogborn: Advanced Practical Physics: Heinemann Educational Publishers; 3rd Revised edition (1 January 1970)
2. Rajopadhye and Purohit: Practical Physics: Asia Publishing House, New Delhi-3
3. S. K. Sharma, R.K. Agrawal, G. Jain, R. Sharma: Practical Physics: Krishna Prakashan Media (Pvt.) Ltd., Meerut, 2019.
4. Harnam Singh and P. S. Hemne: Practical Physics: S. Chand Publishing, (2000).
5. B. L. Flint and H. T. Worsnop: Advanced Practical Physics: Asia Publishing House

Chairman
BOS in Physics

Academic Council 5(5.2)
15th June, 2022

CBCS BSc. PART III SEMESTER V

AECC- C

ENGLISH FOR COMMUNICATION-III (2231501)

SEE- 35 + CA- 15 = 50 marks

COURSE CREDITS 03L+01T=04 **COURSE CONTACT HOUR 60**

Course Objectives:

- To make the students comprehend English language in general
- To enhance the quest for knowledge and correct pronunciations
- To strengthen oral and written communication skills with grammar accuracy
- To galvanize soft skills

Course Outcomes:

By the end of the course the students will be able to:

- Use oral and written English effectively and fluently
- Demonstrate their knowledge of correct pronunciations
- Apply English language skills and grammar accuracy in clearing competitive examinations
- Apply their knowledge of Soft Skills to succeed in career as well as in practical life.

Module No and Title:

Module I: Prose

1. The Gift of the Magi: O' Henry
2. The Homecoming: Rabindranath Tagore
3. The California's Tale: Mark Twain

Module II: Poetry

1. The Solitary Reaper: William Wordsworth
2. The Queen's Rival: Sarojini Naidu
3. Oh! How I faint When I of You Do Write (Sonnet No 80) : William Shakespeare
4. The Road Not Taken: Robert Frost

Module. III: Pronunciation Skills

1) Basic Sounds in English
2) IPA Symbols
3) Phonetic Transcription
4) Stress and Intonation

Module. IV: Soft Skills

1. Types of 21st Century Skills
2. Learning Skills (4Cs)
3. Preparation for Employment

Reference Books:

BA/BSC Part III Compulsory English Literary Mindscapes-I PAH Solapur University, Solapur

(With 20% new additions & changes)

CBCS BSc. PART III SEMESTER VI

AECC- D

ENGLISH FOR COMMUNICATION-IV(2231601)

SEE- 35 + CA- 15 = 50 marks

COURSE CREDITS 03L+01T=04 COURSE CONTACT HOUR 60

Course Objectives:

- To make the students comprehend English language in general
- To enhance the quest for knowledge and correct pronunciations
- To strengthen oral and written communication skills with grammar accuracy
- To galvanize soft skills

Course Outcomes:

By the end of the course the students will be able to:

- Use oral and written English effectively and fluently
- Demonstrate their knowledge of correct pronunciations
- Apply English language skills and grammar accuracy in clearing competitive examinations
- Apply their knowledge of Soft Skills to succeed in career as well as in practical life.

Module No and Title:

Module. I: Prose

1. Growing Up:	Joyce Cary
2. God See the Truth, but Waits:	Leo Tolstoy
3. On the Rule of The Road:	A. G. Gardiner

Module. II: Poetry

1. Sita:	Toru Dutt
2. My Last Duchess:	Robert Browning
3. Ode to Beauty:	John Keats
4. Song: Go and Catch a Falling Star:	John Donne

Module. III: Grammar

1. Simple and Multiple Sentences
2. Direct and Indirect Speech

Module. IV: Soft Skills

1. Literacy Skills
2. Life Skills
3. Employability Skills

<u>Reference Books:</u>

BA/BSC Part III Compulsory English Literary Mindscapes-I PAH Solapur University Solapur (With 20% new additions & changes)

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