

CLUSTER UNIVERSITY: KURNOOL

(Established Under AP Act No. 13 of 2020 and Recognised 2(f) by UGC Act 1956)

B-Camp, KURNOOL-518 002, Andhra Pradesh



BOARD OF STUDIES IN PHYSICS

(As per the new regulations of APSCHE w.e.f. A.Y 2025-26)

Date: 25-07-2026

Syllabus for 4-Year UG Honours in B.Sc. (Physics) as Major in consonance with Curriculum framework w.e.f. AY 2026-27

CURRICULUM FOR II-YEAR B.Sc. PHYSICS

Semester-III & IV (Major & Minor)

For the Academic year 2026-2027

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INTRODUCTION

B.Sc Honours Physics

Physics is the fundamental science that explains the laws governing nature, from sub-atomic particles to the vast expanse of the universe. In the present era of rapid scientific and technological advancement, Physics education must continuously evolve to address emerging challenges, innovations, and the changing global ecosystem. B.Sc. Physics (Honours) is a need-based, concept-driven and skill-oriented programme designed to equip students with strong analytical abilities, scientific temperament, and problem-solving skills essential for academic excellence, research, industry, and societal development.

In accordance with the **National Education Policy (NEP) 2020** guidelines, the **Andhra Pradesh State Council of Higher Education (APSCHE)** has introduced a new curricular framework for undergraduate programmes. The **B.Sc. Physics (Honours)** programme has been structured and offered accordingly from the **academic year 2025–26**, emphasizing multidisciplinary learning, flexibility, and outcome-based education.

The programme provides comprehensive knowledge in **classical mechanics, electricity and magnetism, quantum mechanics, atomic and nuclear physics, solid state physics, mathematical physics, electronics, computational physics, and modern experimental techniques**. Equal importance is given to theoretical foundations, laboratory experiments, computational tools, data analysis, and emerging areas of Physics..

The B.Sc. Physics (Honours) curriculum aims to prepare students for **higher education, scientific research, teaching, competitive examinations, and employment in industries such as electronics, energy, materials science, data analytics, instrumentation, and technology-driven sectors**. The programme also nurtures innovation, critical thinking, and interdisciplinary collaboration, thereby contributing to national development and global scientific progress.

Academic Programme and Admission:

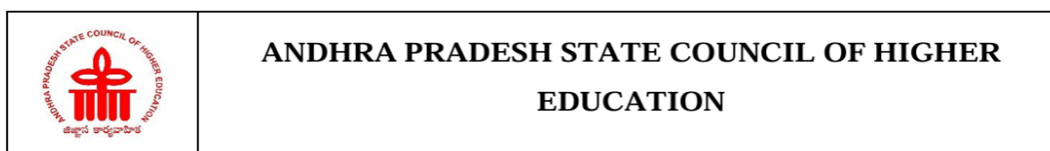
The **B.Sc. Physics (Honours)** programme is offered for **four years** under the **semester system**, in accordance with APSCHE regulations, and includes **short-term and long-term internships, project work, skill enhancement courses, and research-oriented training**. Students who have passed **Intermediate (10+2) with Physics, Chemistry, and Mathematics** or equivalent science streams recognized by APSCHE are eligible for admission. The programme is designed to transform students from passive learners into competent professionals, researchers, and innovators capable of meeting the evolving demands of academia, industry, and society.

Composition of Board of Studies in Physics for the Academic Year 2026-2027 & 2027-2028

S.No.	Name of the Faculty	Designation	Name of the College
1.	Dr Talat Parveen	Chairman	Dept. of Physics, KVR Govt. Degree College for Women, Kurnool-518002, A.P Mobile:9985421907 Email: talatparveen.knl@gmail.com
2.	Prof. C.V.Krishna Reddy	University Nominee	Dept. of Physics, Rayalaseema University, Kurnool- 518 007, A.P. Mobile: 9989642920 Email: reddycvk02@yahoo.co.in
3.	Sri Y Gishnu Nag Vijay	Subject Expert	Dept. of Physics, Silver Jubilee Govt. College, Kurnool-518002. AP Mobile: 9395122131 Email: vijayphysics22@gmail.com
4	Sri B Masood Vali	Subject Expert	Dept. of Physics, Govt College for Men, Kurnool-518002. AP Mobile: 9032249025 Email: bmasoodvali@gmail.com
5.	Dr M Shanawaz Begum	Subject Expert	Dept. of Physics, Silver Jubilee Govt. College, Kurnool-518002, A.P Mobile: 9849863201 Email: drshanawazbegum@gmail.com
6.	Dr M Padmavathi	Subject Expert Quantum Innovation Cell Coordinator	Dept. of Physics, KVR Govt College for Women, Kurnool-518002. AP Mobile: 9160313719 Email: padmaphy.kvr23@gmail.com
7.	Dr Mohammed Waaiz	Subject Expert	Department of Physics Government Degree College Atmakur, Nandyal District. Cell: 9849793821 Email: mdwaaizphysics@gmail.com

Functions:

- Preparation and approval of syllabi of B. Sc. Hons. Physics for the academic years 2026-27 & 2027-28 for Cluster University keeping in view the objectives of the university, interest of the stake holders and national requirement for consideration and approval of the Academic senate.
- Suggestions if any, regarding methodologies for innovative and evaluation techniques
- Suggestions if any, regarding research, teaching, extension and other academic activities in the Physics Department of Cluster university
- Recommending panel of names to the Academic Senate for appointment of Papers Setters and Examiners



Model Syllabus for 4-Year UG Honours in B.Sc. (Physics) as Major in consonance with Curriculum framework w.e.f. AY 2025-26

COURSE STRUCTURE FOR MAJOR COURSES SEMESTER III AND IV

Sno	Year	Semester	Course	Title	No of Hours per Week	No. of Credits
1	II	III	5	Atomic, Molecular & Nuclear physics	3	3
2			5P	Atomic, Molecular & Nuclear physics Practical	2	1
3			6	Basic Electronics	3	3
4			6P	Basic Electronics Practical	2	1
5			7	Applied Optics	3	3
6			7P	Applied Optics practical	2	1
7		IV	8	Electricity, Magnetism and Electromagnetic Theory	3	3
8			8P	Electricity, Magnetism and Electromagnetic Theory Practical	2	1
9			9	Analog Electronics	3	3
10			9P	Analog Electronics Practical	2	1
11			10	Advances in Physics	3	3
12			10P	Advances in Physics Practical	2	1

MINOR COURSES: PHYSICS

COURSE STRUCTURE FOR MINOR COURSES SEMESTER III AND IV (PHYSICS)

Sno	Year	Semester	Course	Title	No of Hours per Week	No. of Credits
1	II	III	1	Mechanics and Properties of Matter	3	3
2			1P	Mechanics and Properties of Matter Practical	2	1
3		IV	2	Waves and Optics	3	3
4			2P	Waves and Optics Practical	2	1

MINOR COURSE: QUANTUM TECHNOLOGIES

COURSE STRUCTURE FOR MINOR COURSES SEMESTER III AND IV (QUANTUM TECHNOLOGIES)

Sno	Year	Semester	Course	Title	No of Hours per Week	No. of Credits
1	II	III	1	Foundations of Quantum Computing: Mathematical and Physical Computing	5	4
2		IV	2	Quantum Technologies: Principles and Applications	5	4

MULTIDISCIPLINARY COURSES

Sno	Year	Semester	Course	Title	No of Hours per Week	No. of Credits
1	II	III	1	Basic Electronics	2	2
2		IV	2	Introduction to Nanotechnology	2	2

RESOLUTIONS

Minutes of the Meeting

The Board of Studies in Physics met on 25-07-2026 discussed and finalized the syllabus under Cluster University prepared based on Common Core Syllabus framed by APSCHE, Vijayawada and unanimously approved the following academic proposals to be implemented from the Academic Year 2026-2027:

- Syllabi of BSc III and IV Semesters (Physics Major& Minor), Quantum Technologies (Minor), for the academic years 2026-2027 under Cluster University keeping in view the objectives of the university, interest of the stake holders and national requirement for consideration and approval of the Academic Senate. The Detailed course structure of all the semester and the theory and practical syllabus are given in Annexure-I
- Panel of names to the Academic Senate for appointment of Papers Setters and Examiners given in Annexure -VI.
- Question Pattern and Model Question Paper in Annexure-III

S.No.	Name of the Faculty	Designation	Name of the College	Signature
1.	Dr Talat Parveen	Chairman	Dept. of Physics, KVR Govt. Degree College for Women, Kurnool 518002, A.P Mobile:9985421907 Email: talatparveen.knl@gmail.com	
2.	Prof. C.V.Krishna Reddy	University Nominee	Dept. of Physics, Rayalaseema University, Kurnool- 518 007, A.P. Mobile: 9989642920 Email: reddycvk02@yahoo.co.in	
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7.	Dr Mohammed Waaiz	Subject Expert	Department of Physics Government Degree College Atmakur, Nandyal District. Cell: 9849793821 Email: mdwaaizphysics@gmail.com	

ANNEXURE - I
SEMESTER-III

COURSE 5: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course aims to introduce students to the principles of atomic structure, molecular spectroscopy, and fundamental nuclear physics. It covers key experimental methods and theoretical models, helping students understand how microscopic interactions lead to observable physical phenomena in atoms, molecules, and nuclei.

LEARNING OUTCOMES:

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

1. Understand the principles of atomic structure and spectroscopy.
2. Understand the principles of molecular spectroscopy.
3. Develop critical understanding of concept of Matter waves and Uncertainty principle.
4. Describe nuclear properties, binding energy, and nuclear models such as the liquid drop and shell model.
5. Explain the working of nuclear detectors and accelerators and classify elementary particles and their interactions.

UNIT-I: INTRODUCTION TO ATOMIC STRUCTURE AND SPECTROSCOPY (9 hrs.)

Introduction to Bohr's model of the hydrogen atom, Vector atom model and Quantum numbers associated with it, Stern and Gerlach experiment, Coupling Schemes (LS & JJ), Spectral terms and spectral notations, Selection rules, Zeeman effect, Experimental arrangement to study Zeeman effect and expression for Zeeman shift(qualitative analysis).

UNIT-II: MOLECULAR SPECTROSCOPY (9 hrs.)

Molecular rotational and vibrational spectra, electronic energy levels and electronic transitions, Raman effect, Characteristics of Raman effect, Experimental arrangement to study Raman effect, Quantum theory of Raman effect, Applications of Raman effect. Spectroscopic techniques: IR and UV-Visible.

UNIT-III: MATTER WAVES & UNCERTAINTY PRINCIPLE (9 hrs.)

Matter waves, de Broglie's hypothesis, Properties of matter waves, Davisson and Germer's experiment, Heisenberg's uncertainty principle for position and momentum & energy and time, Illustration of uncertainty principle using diffraction of beam of electrons (Diffraction by a single slit) and photons (Gamma ray microscope).

UNIT-IV: INTRODUCTION TO NUCLEAR PHYSICS**(9 hrs)**

Nucleus: Properties of nucleus, Mass defect, Binding energy – binding energy curve; Nuclear forces: Characteristics of nuclear forces, Yukawa's meson theory; Nuclear Models- Liquid drop model- Semi empirical mass formula, Shell model, magic numbers.

UNIT-V: NUCLEAR DETECTORS AND NUCLEAR ACCELERATOR**(9 hrs)**

Nuclear detectors: Geiger- Muller counter, Cloud chamber (expansion type), Scintillation counter. Nuclear Accelerators: Cyclotron-construction, working and applications; Synchrocyclotron-construction, working and applications. Classification of elementary particles, Types of interactions- strong, electromagnetic and weak interactions;

REFERENCE BOOKS:

1. BSc Physics, Vol.4, Telugu Academy, Hyderabad
2. Atomic Physics by J.B. Rajam; S. Chand & Co.,
3. Modern Physics by R. Murugesan and Kiruthiga Siva Prasath. S. Chand & Co.
4. Concepts of Modern Physics by Arthur Beiser. Tata McGraw-Hill Edition.
5. Nuclear Physics, Irving Kaplan, Narosa Pub. (1998).
6. Nuclear Physics, Theory and experiment – P.R. Roy and B.P. Nigam, New Age Int.1997.
7. Atomic and Nuclear Physics (Vol.2), S.N. Ghoshal, S. Chand & Co. (1994).
8. Nuclear Physics, D.C. Tayal, Himalaya Pub. (1997).

SEMESTER-III

COURSE 5: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To develop practical skills and experimental understanding in atomic and nuclear physics, including spectral line measurements, particle detection, and verification of quantum and nuclear models.

LEARNING OUTCOMES:

1. Demonstrate a deep understanding of the principles and theories of modern physics through hands-on experimentation and data analysis.
2. Analyze and interpret experimental data using statistical methods and error analysis, drawing meaningful conclusions and relating them to theoretical concepts.
3. Design and conduct independent experiments or investigations related to modern physics, demonstrating the ability to plan, execute, and analyze experimental procedures and results.
4. Gain a solid understanding of fundamental concepts in nuclear physics.
5. Understand the principles and operation of laboratory equipment and instruments specific to nuclear physics experiments.
6. Develop proficiency in conducting experiments related to nuclear physics.

Minimum of 6 experiments to be done and recorded

1. e/m of an electron by Thomson method
2. Determination of Planck's constant using a photocell
3. Verification of inverse square law of light using photovoltaic cell
4. Determination of work function of the filament material using directly heated vacuum diode
5. GM counter – Determination of dead time
6. Study of characteristic curve of GM counter and estimation of its operating voltage
7. Estimation of efficiency for a gamma source using GM counter
8. Estimation of efficiency for a beta source using GM counter
9. Study of sodium doublet using a diffraction grating
10. IR or UV-Vis spectroscopy of samples using a portable spectrometer
11. Single slit diffraction of laser beam to illustrate uncertainty principle
12. Study of absorption of beta particles in aluminum sheets
13. Study of Compton scattering (demo or simulation)
14. Study of counting statistics using GM counter
15. Study of plateau region and dead time using a counting system

SEMESTER-III

COURSE 6: BASIC ELECTRONICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVES

This course aims to introduce undergraduate physics students to the fundamental principles of electronics. It covers passive components, semiconductor physics, diode and transistor operation, DC power supplies, and the basics of digital logic. The goal is to build a solid foundation in circuit analysis and electronic devices for students with minimal prior background.

LEARNING OUTCOMES:

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

1. Identify and explain the function and types of resistors, capacitors, and inductors.
2. Understand the basic concepts of semiconductors and diode characteristics.
3. Analyze simple transistor circuits and their applications.
4. Describe the functioning of rectifiers, filters, and voltage regulators.
5. Perform basic binary arithmetic and construct simple digital logic circuits.

UNIT I: PASSIVE COMPONENTS AND CIRCUIT FUNDAMENTALS (9 hrs)

Resistors: Types (carbon, wire-wound, metal film), color coding, tolerance, power ratings - Capacitors: Types (ceramic, electrolytic, film), applications, charge/discharge behavior - Inductors: Basic structure and applications - **Series and parallel combinations: Equivalent resistance/capacitance/inductance** - Basic laws: Ohm's Law, Kirchhoff's Voltage and Current Laws (KVL, KCL) with simple applications

UNIT II: SEMICONDUCTOR PHYSICS AND DIODES (9 hrs)

Intrinsic vs extrinsic semiconductors - Doping, energy band diagrams, charge carriers - PN junction diode: Construction, working, forward/reverse biasing, I-V characteristics - Special diodes: Zener diode-**voltage regulator**, LED, photodiode, solar cell – construction, characteristics and uses

UNIT III: TRANSISTORS AND THEIR OPERATION (9 hrs)

BJT: Structure, current components, working of NPN/PNP – Transistor Configurations: CB, CE, CC. **Input/output characteristics of CE configuration.** Applications: Transistor as switch and amplifier (qualitative understanding)

UNIT IV: POWER SUPPLIES AND REGULATION (9 hrs)

Need for DC power supply: Block diagram - Rectifiers: Half-wave, full-wave, bridge with waveforms - Filter circuits: RC, LC, and π filters – working principle - Voltage regulation: **Zener diode regulation**, IC regulators (brief intro)

UNIT V: INTRODUCTION TO DIGITAL ELECTRONICS

(9 hrs)

Analog vs Digital signals - Number systems: Binary, decimal, hexadecimal – conversions, binary arithmetic - Logic gates: AND, OR, NOT – symbols, truth tables, simple logic circuits , Universal gates (NAND, NOR) – brief introduction, **Boolean Laws and De Morgan's Theorems.**

Textbooks / References:

1. V.K. Mehta & Rohit Mehta – *Principles of Electronics*, S. Chand
2. R.S. Sedha – *A Textbook of Applied Electronics*, S. Chand
3. D. Chattopadhyay & P.C. Rakshit – *Electronics: Fundamental Concepts*, New Central
4. Malvino & Leach – *Digital Principles and Applications*, McGraw-Hill
5. A.K. Maini – *Digital Electronics*, Wiley India

SEMESTER-III

COURSE 6: BASIC ELECTRONICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To develop practical skills in handling basic electronic components and circuits by constructing, testing, and analyzing simple electronic systems such as rectifiers, filters, diode/transistor configurations, and digital logic gates using fundamental measurement tools.

Learning Outcomes

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

1. Measure and verify the behavior of passive components in circuits.
2. Construct and test diode and transistor-based circuits.
3. Analyze rectifier output and filter performance using basic instruments.
4. Build and verify logic gate circuits using ICs or trainer kits.
5. Practice circuit debugging, use of multimeters, and interpretation of waveforms using a CRO.

Minimum of 6 experiments to be done and recorded

Experiments (Practical List)

1. **Verification of Ohm's Law** using resistive networks (series and parallel combinations).
2. **Series and Parallel Combination of Capacitors and Inductors**
3. **Capacitor charging and discharging curves** using RC circuits and a stopwatch/multimeter.
4. **V-I characteristics of a PN junction diode** (forward and reverse bias)
5. Temperature Dependence of Resistance (Using Thermistor).
6. **Zener diode characteristics** and voltage regulation behavior.
7. **Study of LED and photodiode characteristics** under different light conditions.
8. **BJT transistor as a switch**: ON/OFF control of an LED.
9. **Construction of half-wave and full-wave rectifiers** and measurement of output voltage.
10. **Design and analysis of simple π -filtered power supply** circuits.
11. **Verification of logic gates (AND, OR, NOT, NAND, NOR)** using digital ICs or simulation.
12. Verification of De-Morgan's theorems

SEMESTER-III

COURSE 7: APPLIED OPTICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

This course aims to introduce students to the core principles of optics and the functioning of various optical instruments. The objective is to provide a clear understanding of ray optics, aberrations, lasers, optical fibers, holography, and their applications in modern optical systems such as microscopes and telescopes.

LEARNING OUTCOMES:

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

1. Understand the fundamentals of geometrical optics using ray matrices and apply them to complex lens systems.
2. Analyze and distinguish various types of optical aberrations and methods to minimize them.
3. Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields.
4. Understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.
5. Gain knowledge of various optical instruments including microscopes and telescopes, their types, and real-world applications

UNIT-I: GEOMETRICAL OPTICS

(9 hrs.)

Ray optics assumptions, Fermat principle, Translation matrix, Reflection matrix, Refraction matrix, ABCD matrices system matrix, Thick lens formula, Thin lens formula, Ramsden eyepiece, Huygens eyepiece, Two lens formula - (i) separated by a distance and (ii) in contact.

UNIT-II: ABERRATIONS

(9 hrs.)

Fresnel theory of Reflection and Refraction. Monochromatic aberrations, Spherical aberration, Methods of minimizing spherical aberration, Coma, Astigmatism and Curvature of field, Distortion; Chromatic aberration-the achromatic doublet; Achromatism for two lenses (i) in contact and (ii) separated by a distance.

UNIT-III: LASERS

(9 hrs.)

Lasers: Introduction, **Stimulated absorption**, Spontaneous emission, Stimulated emission, Population Inversion, Laser principle, Einstein coefficients, Types of lasers: He-Ne laser, Ruby laser, Semiconductor laser, Applications of laser.

UNIT-IV: OPTICAL FIBERS AND HOLOGRAPHY

(9 hrs.)

Principle of Optical fibers, Acceptance angle, Acceptance cone, Numerical aperture, Types of optical fibers - Graded and Stepped index, **Types Signal attenuation mechanisms in optical fibers**, Applications of Optical fibers - Sensors, **Imaging**, Communication.

Holography: Basic principle of holography-Gabor hologram and its limitations, Applications of holography.

UNIT-V: APPLICATIONS OF OPTICAL INSTRUMENTS

(9 hrs.)

Introductory ideas and applications of various microscopes viz., (i) Optical microscopes (**Simple microscope**, Compound microscope, **Confocal microscope**) (ii) Electron microscopes – SEM, **TEM** Introductory ideas and applications of various telescopes viz., (i) Optical telescopes (ii) Radio telescopes (iii) **Solar telescopes** (iv) **Infrared telescope** (v) Ultraviolet telescope

REFERENCE BOOKS:

1. BSc Physics, Vol.2, Telugu Academy, Hyderabad.
2. Optics - principles and applications Kailash K. Sharma
3. An introduction to Lasers M N Avadhanulu
4. Lasers Tyagarajan Ghatak 2nd Ed.
5. Introduction to Fiber Optics Tyagarajan Ghatak
6. Principles of Laser material processing Elijah Kannatey Asibu
7. Quantum optics an introduction Mark Fox

SEMESTER-III

COURSE 7: APPLIED OPTICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To provide hands-on experience with optical components and instruments, and to reinforce theoretical concepts through practical applications involving lasers, optical fibers, microscopes, and ray optics techniques.

LEARNING OUTCOMES:

1. Understand and apply geometrical optics principles through practical experiments involving lens combinations, matrix methods, and measurement of focal lengths using systems like the two-lens setup.
2. Demonstrate hands-on understanding of monochromatic and chromatic aberrations by working with diffraction gratings and measuring resolving powers of optical components like gratings and telescopes.
3. Explore the operational principles and characteristics of lasers, including wavelength measurement using diffraction gratings and analysis of laser beam behavior through reflection and refraction experiments.
4. Operate and analyze optical fiber systems by determining the numerical aperture, acceptance angle, and exploring their applications in communication and light guiding.
5. Investigate holographic concepts by understanding the role of laser light in interference-based techniques and identifying the limitations of basic holographic setups.
6. Examine and interpret the working of various optical instruments such as microscopes and telescopes by studying resolution, power, and optical limitations through practical experiments and simulations.

Minimum of 6 experiments to be done and recorded

1. Wavelength of laser using Diffraction grating
2. Refractive index of liquid using Hollow prism
3. Resolving power of telescope
4. Resolving power of grating
5. Spectrometer: i-d curve
6. Laser Reflection grating using metal scale
7. Optical fiber - Numerical Aperture
8. Rabi Oscillations Octave program
9. Two lens system power pairs plot (Python/Octave)
10. Focal length and verification of matrix method for thick and thin lenses
11. Achromatic combination of two lenses – in contact and at a distance
12. Measurement of beam divergence and spot size of a laser
13. Verification of Malus' Law using a laser and polarizers
14. Study of diffraction pattern from circular aperture (Airy disk) – resolving limit
15. Young's double-slit experiment using laser – interference fringes and fringe width
16. Study of bending losses in optical fiber

SEMESTER-IV

COURSE 8: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Electricity, Magnetism and Electromagnetic theory aims to provide students with a fundamental understanding of the principles of electricity, magnetism, and electromagnetic theory.

LEARNING OUTCOMES:

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

1. Understand the Gauss law and its application to obtain electric field in different cases and formulate the relationship between electric displacement vector, electric polarization, Susceptibility, Permittivity and Dielectric constant.
2. To learn the methods used to solve problems using loop analysis, Nodal analysis, Thevenin's theorem, Norton's theorem, and the Superposition theorem
3. Distinguish between the magnetic effect of electric current and electromagnetic induction and apply the related laws in appropriate circumstances.
4. Understand Biot and Savart's law and Ampere's circuital law to describe and explain the generation of magnetic fields by electrical currents.
5. Develop an understanding on the unification of electric, and magnetic fields and Maxwell's equations governing electromagnetic waves.
6. Phenomenon of resonance in LCR AC-circuits, sharpness of resonance, Q- factor, Power factor and the comparative study of series and parallel resonant circuits

UNIT-I: ELECTROSTATICS AND DIELECTRICS

(9 hrs)

Gauss's law - Statement and its proof, Electric field intensity due to uniformly charged solid sphere, Electrical potential-Equipotential surfaces, Potential due to a uniformly charged sphere. Dielectrics-Polar and Non-polar dielectrics - Effect of electric field on dielectrics, Dielectric strength, Electric displacement D, electric polarization Relation between D, E and P, Dielectric constant and electric susceptibility and **relation between them.**

UNIT-II: CURRENT ELECTRICITY

(9 hrs)

Electrical conduction - drift velocity-current density, equation of continuity, **ohms law and limitations**, Kirchhoff's Law's, Branch current method, Nodal Analysis, Star to Delta & Delta to Star conversions. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer theorem.

UNIT-III: MAGNETOSTATICS AND ELECTROMAGNETIC INDUCTION (9 hrs)

Magneto statics: Biot-Savart's law and its applications: (i) long straight wire and (ii) circular loop, Hall Effect, determination of Hall coefficient and applications, magnetic charge, concept of vector potential.

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, Self-induction and Mutual induction, Self-inductance of a long solenoid, Magnetic Energy density, mutual inductance of a pair of coils, coefficient of Coupling.

UNIT-IV ELECTROMAGNETIC WAVES-MAXWELL'S EQUATIONS (9 hrs)

Maxwell's equations: integral and differential forms (No derivation), Continuity equation, Concept of displacement current. Plane electromagnetic wave equation, Hertz experiment - Transverse nature of electromagnetic waves, Electromagnetic wave equation in conducting media, Skin depth, Poynting theorem-Pointing vector, **Wave equations for E & B, Maxwell's equations in matter.**

UNIT-V VARYING AND ALTERNATING CURRENTS (9 hrs)

Growth and decay of currents in LR, CR, LCR circuits (brief introduction)-Critical damping, alternating current - A.C. fundamentals, and A.C through pure R, L and C, Relation between current and voltage in LR and CR circuits, Phasor and Vector diagrams, LCR series and parallel resonant circuit, **LCR tuning circuit**, Q - factor, Power in ac circuits, Power factor.

REFERENCE BOOKS:

1. BSc Physics, Vol.3, Telugu Academy, Hyderabad.
2. Electricity and Magnetism, D.N. Vasudeva. S. Chand & Co.
3. Electricity, Magnetism with Electronics, K.K. Tewari, R. Chand & Co.,
4. "Electricity and Magnetism" by Brijlal and Subramanyam Ratan Prakashan Mandir, 1966
5. "Electricity and Magnetism: Fundamentals, Theory, and Applications" by Murugesan, Kiruthiga Siva prasath, and M. Saravanapandian
6. "Electricity and Magnetism: Theory and Applications" by Ajoy Ghatak and Lokanathan
7. Electricity and Magnetism: Problems and Solutions" by Ashok Kumar and Rajesh Kumar
8. Electricity and Magnetism, R.Murugesan, S. Chand & Co.

SEMESTER-IV

COURSE 8: ELECTRICITY, MAGNETISM AND ELECTROMAGNETIC THEORY

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The Course Objective for a practical course in electricity and magnetism may include to develop practical skills in handling electrical and electronic components, such as resistors, capacitors, inductors, transformers, and oscillators.

LEARNING OUTCOMES:

1. Demonstrate a thorough understanding of the fundamental concepts and principles of electricity and magnetism.
2. Apply the laws and principles of electricity and magnetism to analyze and solve electrical and magnetic problems.
3. Design, construct, and test electrical circuits using various components and measuring instruments.
4. Measure and analyze electrical quantities such as voltage, current, resistance, capacitance, and inductance using appropriate instruments.
5. Apply the principles of electromagnetism to understand and analyze the behavior of magnetic fields and their interactions with electric currents

Minimum of 6 experiments to be done and recorded

1. LCR circuit series resonance, Q factor.
2. LCR circuit parallel resonance, Q factor.
3. Determination of AC-frequency –Sonometer.
4. Verification of Kirchhoff's laws and Maximum Power Transfer theorem.
5. Field along the axis of a circular coil carrying current-Stewart & Gee's apparatus.
6. Charging and discharging of CR circuit-Determination of time constant
7. A.C Impedance and Power factor
8. Determination of specific resistance of wire by using Carey Foster's bridge.
9. Study of electric field and equipotential lines using conducting paper/Solution
10. Measurement of inductance using bridge method (Maxwell's or Anderson's bridge)
11. Demonstration of electromagnetic shielding (Faraday cage effect)
12. Study of skin effect using high-frequency AC and measuring resistance variation
13. Simulation of electromagnetic wave propagation using MATLAB/Python
14. Poynting vector direction demonstration using polarizers and wave sources (conceptual demo)
15. Q factor and resonance frequency using CRO in LCR circuits (with variable frequency AC generator)

SEMESTER-IV

COURSE 9: ANALOG ELECTRONICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

To build on the understanding of transistor and op-amp-based analog circuits, enabling students to analyze and design amplifiers, oscillators, and basic analog signal processing systems for real-world applications.

LEARNING OUTCOMES:

By the end of the theory course, the student will be able to:

1. Analyze the design and performance of BJT amplifier circuits and multistage configurations.
2. Distinguish between different classes of power amplifiers and understand feedback principles.
3. Understand the internal operation and characteristics of operational amplifiers.
4. Design practical op-amp-based analog circuits for mathematical operations and signal conditioning.
5. Explain the principles of sinusoidal oscillator circuits and their applications.

UNIT I: BJT AMPLIFIERS

(9 hrs)

Review of transistor operation in CE configuration - Load line analysis, biasing concepts (fixed bias, voltage divider bias) - CE amplifier: Circuit, gain, input/output impedance - Frequency response, bandwidth - Multistage amplifiers and emitter follower (voltage follower)

UNIT II: POWER AND FEEDBACK AMPLIFIERS

(9 hrs)

Classification of amplifiers: Class A, B, AB, C - Class A and Class B power amplifiers – working and efficiency - Push-pull amplifier – circuit and waveforms - Negative feedback: Types (voltage/current series/shunt), effect on gain, bandwidth, stability

UNIT III: OPERATIONAL AMPLIFIERS – BASICS

(9 hrs)

Characteristics of ideal and practical op-amp - Parameters: CMRR, slew rate, input offset voltage, bias current - Pin configuration and block diagram of IC 741 - Open loop and closed loop configuration

UNIT IV: APPLICATIONS OF OP-AMPS

(9 hrs)

Inverting and non-inverting amplifiers – gain derivation and characteristics - Adder, subtractor circuits - Integrator and differentiator – design and applications - Comparators and zero-crossing detectors

UNIT V: OSCILLATOR CIRCUITS

(9 hrs)

Conditions for oscillations: Barkhausen criterion - RC oscillators: Phase shift oscillator, Wein bridge oscillator – circuit, working - LC oscillators: Hartley, Colpitts – basic theory and circuits - Crystal oscillator: Construction and applications

Textbooks / References:

1. Robert L. Boylestad – *Electronic Devices and Circuit Theory*, Pearson
2. Ramakant A. Gayakwad – *Op-Amps and Linear Integrated Circuits*, PHI
3. D. Roy Choudhury – *Linear Integrated Circuits*, New Age International
4. A.P. Malvino – *Electronic Principles*, Tata McGraw-Hill
5. Millman & Halkias – *Integrated Electronics*, McGraw-Hill

SEMESTER-IV

COURSE 9: ANALOG ELECTRONICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To provide hands-on experience in constructing and analyzing analog circuits involving BJTs, operational amplifiers, and oscillator configurations using commonly available components and instruments.

LEARNING OUTCOMES:

By the end of the lab course, the student will be able to:

1. Design and analyze various transistor amplifier circuits.
2. Measure amplifier parameters such as voltage gain, bandwidth, and input/output impedance.
3. Implement analog signal processing circuits using op-amps.
4. Test sinusoidal oscillator circuits and identify working conditions.
5. Utilize function generators, power supplies, and CROs for analog circuit testing..

Minimum of 6 experiments to be done and recorded

1. **CE amplifier design and performance:** Measure voltage gain and bandwidth.
2. **Transistor biasing circuits:** Fixed bias and voltage divider bias—measurement of Q-point.
3. **Class-B push-pull amplifier:** Construction and efficiency estimation.
4. **Negative feedback amplifier:** Study gain variation with and without feedback.
5. **Study of IC 741 op-amp parameters:** Offset voltage, bias current, and CMRR.
6. **Op-amp inverting and non-inverting amplifiers:** Gain and phase comparison.
7. **Op-amp adder and subtractor circuits:** Build and verify output equations.
8. **Op-amp integrator and differentiator:** Observe and sketch output waveforms.
9. **Wein bridge oscillator using op-amp or transistor:** Frequency and waveform measurement.
10. **Phase-shift oscillator** using RC networks and op-amp.

11. **Studying sine wave characteristics(amplitude, frequency, time period) using CRO**

SEMESTER-IV

COURSE 10: ADVANCES IN PHYSICS

Theory

Credits: 3

3 hrs/week

Course Objectives

1. To introduce students to fundamental concepts of quantum mechanics, classical mechanics, and the evolution of computing with emphasis on quantum computing principles.
2. To expose students to emerging areas in physics, including nanotechnology and renewable energy, and their practical applications in modern technology and sustainable development.

Learning Outcomes

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

1. Apply basic quantum mechanics concepts including the Schrödinger equation, quantum postulates, and Pauli matrices to simple physical systems.
2. Formulate and solve mechanical problems using Lagrangian and Hamiltonian formulations of classical mechanics.
3. Trace the historical and technological evolution of computers, and explain the significance of quantum algorithms and the concept of quantum supremacy.
4. Identify and describe types of nanomaterials and discuss their unique properties and applications in science and technology.
5. Compare various renewable energy sources and explain principles of energy generation, storage, and integration into modern power grids.

UNIT-I CONCEPTS OF QUANTUM MECHANICS

(9 hrs.)

Photoelectric effect, Compton Effect, Schrodinger's wave Equation time dependent, Time independent, Postulates of Quantum mechanics, Properties of wave function, Expectation values. One-dimensional problems - Particle in a box. Pauli spin matrices.

UNIT-II LAGRANGIAN MECHANICS

(9 hrs.)

Conservation laws, Constraints, Generalized coordinates and velocities, Virtual displacement, principle of virtual work, D'Alembert Principle, Lagranges equation of motion, Application-Simple pendulum, Atwood machine. Principle of least action, Hamiltonian equation of motion, **Legendre transformation**.

UNIT III EVOLUTION OF COMPUTERS

(9 hrs.)

Computers: Mechanical to electronic evolution, Generations of computers: Vacuum tubes, transistors, ICs, microprocessors, Moore's Law and classical computing limitations, Need for a new paradigm: Introduction to quantum concepts, Key contributions from Feynman, Deutsch, Overview of Shor's and Grover's algorithms, Concept and implications of quantum supremacy

UNIT IV: FUNDAMENTALS OF NANOTECHNOLOGY

(9 hrs.)

Introduction to Nanoscience and Nanotechnology, Definition, historical development, and importance. Volume to Surface ratio, quantum effects, Types of Nanomaterials: Nanoparticles, nanowires, nanotubes, quantum dots. Applications of Nanotechnology: In electronics, medicine, energy, and environment

UNIT V: RENEWABLE ENERGY

(9 hrs.)

Conventional and Non-conventional energy sources. Renewable energy and its resources
Solar energy - Generation, energy storage. Grid Integration and Smart Grids
Green energies - Wind energy, Biomass energy, Tidal energy and green energy, Fuel cells

Books and References

1. **Quantum Mechanics: Concepts and Applications** – Nouredine Zettili
2. **Principles of Quantum Mechanics** – R. Shankar
3. **A Textbook of Quantum Mechanics** – P.M. Mathews and K. Venkatesan (*Indian Author*)
4. **Classical Mechanics** – H. Goldstein, C. Poole, and J. Safko
5. **Introduction to Classical Mechanics** – R.G. Takwale and P.S. Puranik (*Indian Author*)
6. **Classical Mechanics** – J.C. Upadhyaya (*Indian Author*)
7. **Computer Organization and Architecture** – William Stallings
8. **Quantum Computation and Quantum Information** – Michael A. Nielsen and Isaac L. Chuang
9. **Fundamentals of Computers** – V. Rajaraman (*Indian Author*)
10. **Quantum Mechanics and Path Integrals** – Richard P. Feynman and A.R. Hibbs
11. **Introduction to Nanotechnology** – Charles P. Poole Jr. and Frank J. Owens
12. **Nanoscience and Nanotechnology** – M.A. Shah and Tokeer Ahmad (*Indian Author*)
13. **Renewable Energy Resources** – John Twidell and Tony Weir
14. **Non-Conventional Energy Sources** – G.D. Rai (*Indian Author*)
15. **Solar Energy: Principles of Thermal Collection and Storage** – S.P. Sukhatme and J.K. Nayak (*Indian Author*)

SEMESTER-IV

COURSE 10: ADVANCES IN PHYSICS

Practical

Credits: 1

1 hrs/week

Course Objective:

To provide students with hands-on experience and demonstrations of fundamental and emerging concepts in modern physics through physical and simulated experiments, focusing on quantum phenomena, material properties, energy technologies, and basic nanoscience.

Learning Outcomes

After successful completion of the course, the student will be able to:

1. **Demonstrate understanding of quantum and thermal physics principles** through experiments such as photoelectric effect and Boltzmann constant determination.
2. **Analyze electrical and magnetic properties** of materials using real measurements (resistivity, magnetization, LDR, etc.).
3. **Explore basic properties of nanomaterials and their synthesis** through simple laboratory techniques like green synthesis of nanoparticles.
4. **Develop awareness of renewable energy technologies** and compare efficiencies of energy devices like solar panels, LEDs, and fuel cells.
5. **Apply instrumentation skills** in using sensors, CROs, and circuit components for measuring physical parameters.
6. **Interpret results from simulated experiments** and link theoretical physics models with practical outcomes (e.g., Maxwell-Boltzmann distribution, particle in a box).
7. **Enhance scientific inquiry and experimental reporting skills** through observations, data analysis, and interpretation.

A minimum of 6 experiments to be performed and recorded

1. Photoelectric Effect using UV LED and LDR
 - Demonstrates threshold frequency and energy quantization.
2. Determination of Boltzmann Constant from Diode Characteristics
 - Uses current–voltage relation of a diode.
3. Simple Pendulum – Time Period vs. Lagrangian Prediction
 - Validates theoretical dynamics.
4. Atwood Machine – Verification of Newton's Laws
 - Demonstrates conservation of energy and force analysis.
5. LCR Circuit and Impedance Measurement
 - Explores phase relations and resonance in AC circuits..
6. Synthesis of Iron Oxide Nanoparticles (Green Method)
 - Simple and safe wet-chemical synthesis using plant extracts.
7. Surface Area to Volume Ratio Demonstration Using Sugar Cubes/Sponge
 - Explains nanoscale effects visually.

8. Wind Energy Demonstration (Fan + Mini Turbine Setup)
 - Demonstrates wind-to-electricity conversion.
9. Hydrogen Generation via Electrolysis and Fuel Cell Demonstration
 - Produces H₂ and shows voltage from a fuel cell.
10. Efficiency Comparison Between LED and Incandescent Bulbs
 - Measures power consumption and light output.
11. Solar Panel Efficiency under Different Light and Load Conditions
 - Demonstrates photovoltaic energy conversion and optimization.
12. Battery/Fuel Cell Voltage Measurement with Varying Load
 - Observes how output voltage changes with load resistance.

Simulation-Based or Digital Experiments

13. 1D Particle in a Box – Simulation using PhET/Python
 - Visualizes quantum confinement and energy levels.
14. Rutherford Scattering Simulation
 - Models scattering patterns and cross-section concepts.
15. Spin- $\frac{1}{2}$ System and Pauli Matrices – Qiskit or QuTiP
 - Simulates spin operators and quantum states.
16. Visualization of Kepler's Laws and Satellite Orbits
 - Models elliptical motion and geostationary conditions.
17. Lagrangian and Hamiltonian Simulation (e.g., Double Pendulum)
 - Explores classical mechanics through dynamic systems..
18. Basic Quantum Circuit Simulation using IBM Quantum Lab (Qiskit)
 - Visualizes gates, superposition, and basic algorithms.

SEMESTER-III

Minor-Physics

COURSE 1: MECHANICS AND PROPERTIES OF MATTER

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Mechanics and Properties of Matter aims to provide students with a fundamental understanding of the behavior of physical systems, both in terms of mechanical motion and in terms of the properties of matter.

LEARNING OUTCOMES:

1. Students will be able to apply the laws of motion, solve equations of motion for variable mass systems.
2. Students will be able to define central forces and provide examples, understand the characteristics and conservative nature of central forces, to derive equations of motion under central forces.
3. Students will be able to define and relate elastic constants, interpret stress-strain relationships, and analyze bending in beams.
4. Students will be able to apply the basic principles of fluid dynamics including Bernoulli's theorem, viscosity, and surface tension in practical contexts.
5. Students will be able to differentiate between Galilean relativity and the concept of absolute frames, comprehend the postulates of the special theory of relativity, apply Lorentz transformations, understand and solve problems.

UNIT-I MECHANICS OF PARTICLES

(9 hrs)

Newton's Laws of motion, motion of variable mass system, Equation of motion of a rocket. Conservation of energy and momentum, collisions in two and three dimensions, concept of impact parameter, scattering cross-section, Rutherford scattering-derivation

UNIT-II CENTRAL FORCES

(9 hrs)

Central forces, definition and examples, characteristics of central forces, conservative nature of central forces, conservative force as a negative gradient of potential energy, equations of motion under a central force, derivation of Kepler's laws, motion of satellites, Geo-stationary satellites

UNIT III: ELASTICITY AND BENDING OF BEAMS

(9 hrs)

Stress and strain, Hooke's Law, Elastic moduli – Young's, bulk, and shear modulus, Poisson's ratio – Physical meaning, bending of beams – Types, point and distributed load, Cantilever and uniform bending – Qualitative treatment, Torsional pendulum – working principle and uses.

UNIT IV: FLUID MECHANICS

(9 hrs)

Fluids: Properties and classification, Streamline vs. turbulent flow, Reynolds number, Bernoulli's theorem – Statement, simple derivation and applications (**Venturimeter**, airplane lift), Equation of continuity – Concept, Viscosity – Poiseuille's law (statement and qualitative explanation), Surface tension – Examples and qualitative ideas

UNIT V: SPECIAL THEORY OF RELATIVITY

(9 hrs)

Galilean relativity, absolute frames, Michelson-Morley experiment, negative result, postulates of special theory of relativity, Lorentz transformation, time dilation, length contraction, addition of velocities, mass-energy relation

REFERENCE BOOKS:

1. BSc Physics -Telugu Akademy, Hyderabad
2. Mechanics - D.S. Mathur, Sulthan Chand & Co, New Delhi
3. Mechanics - J.C. Upadhyaya, Ramprasad & Co., Agra
4. Properties of Matter - D.S. Mathur, S. Chand & Co, New Delhi ,11th Edn., 2000
5. Physics Vol. I - Resnick-Halliday-Krane ,Wiley, 2001
6. Properties of Matter – Brijlal & Subrmayam, S. Chand & Co. 1982
7. Mechanics-EM Purcell, Mc Graw Hill
8. University Physics-FW Sears, MW Zemansky & HD Young, Narosa Publications, Delhi
9. College Physics-I. T. Bhima sankaram and G. Prasad. Himalaya Publishing House.
10. Mechanics, S. G. Venkata chalapathy, Margham Publication, 2003.
11. Fluid Mechanics – Frank M. White, McGraw Hill.
12. Textbook of Fluid Dynamics – M. D. Raisinghania, S. Chand & Co.

SEMESTER-III
Minor-Physics
COURSE 1: MECHANICS AND PROPERTIES OF MATTER

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To develop practical skills in the use of laboratory equipment and experimental techniques for measuring properties of matter and analyzing mechanical systems.

LEARNING OUTCOMES:

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques to measure properties of matter and analyze mechanical systems.
2. Application of theory to practice: Students should be able to apply theoretical concepts learned in lectures to real-world situations, and understand the limitations of theoretical models.
3. Accurate recording and analysis of data: Students should be able to accurately record and analyze experimental data, including understanding the significance of error analysis and statistical methods.
4. Critical thinking and problem solving: Students should be able to identify sources of error, troubleshoot experimental problems, and develop critical thinking skills in experimental design and analysis.
5. Understanding of physical principles: Students should develop an understanding of the physical principles governing mechanical systems and the properties of matter, including elasticity, viscosity, and thermal expansion.

Minimum of 6 experiments to be done and recorded

1. Young's modulus by uniform bending
2. Young's modulus by non-uniform bending
3. Rigidity modulus using torsional pendulum
4. Viscosity of liquid by Poiseuille's method
5. Surface tension by capillary rise method
6. Flywheel – Determination of moment of inertia
7. Viscosity of liquid by Searle's viscometer method
8. Bifilar suspension – moment of inertia of a rectangular body
9. Radius of capillary tube by Hg thread method
10. Optional Simulation-based activity: Time dilation or projectile simulation.

SEMESTER-IV
Minor-Physics
COURSE 2: WAVES AND APPLIED OPTICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

This course introduces the physical principles of oscillatory motion, interference, and polarization of light, and explores modern optical phenomena including lasers, optical fibers, and holography. The objective is to build a deep conceptual understanding of wave behavior in mechanical and optical systems and their technological applications.

LEARNING OUTCOMES:

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

1. Describe the basic characteristics of waves such as frequency, wavelength, amplitude, period, and speed and utilize mathematical relationships related to wave characteristics.
2. Understand the phenomenon of interference of light and its formation in Thin films and Newton's rings and Distinguish between Fresnel's diffraction and Fraunhofer diffraction and observe the diffraction patterns in the case of single slit.
3. Explain the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.
4. Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields.
5. Understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.

UNIT-I: SIMPLE HARMONIC, DAMPED & FORCED OSCILLATIONS (9hrs)

Simple Harmonic Oscillator: Solution of differential equation, and physical characteristics, Principle of superposition, Combination of two mutually perpendicular SHMs (1:1 and 1:2 frequencies), Lissajous figures. Damping, Damped Harmonic Oscillator: Solution of differential equation, Energy considerations, Logarithmic decrement, relaxation time, quality factor, Forced Oscillations: Solution of differential equation.

UNIT-II: INTERFERENCE AND DIFFRACTION (9 hrs)

Interference: Principle of superposition – coherence Conditions for interference of light. Fresnel's biprism determination of wavelength of light, change of phase on reflection,

Oblique incidence of a plane wave on a thin film due to reflected light (cosine law) –Newton's rings in reflected light. Determination of wavelength of monochromatic light using Newton's rings.

Diffraction: Introduction, distinction between Fresnel and Fraunhofer diffraction, Fraunhofer diffraction – Diffraction due to single slit, Difference between interference and diffraction.

UNIT-III: POLARIZATION

(9 hrs)

Polarized light: methods of polarization by reflection, refraction, double refraction, Brewster's law, Malus law, Nicol prism polarizer and analyser, Quarter wave plate, Half wave plate, optical activity - Determination of specific rotation by Laurent's half shade Polarimeter. Idea of elliptical and circular polarization

UNIT-IV: LASERS

(9 hrs)

Lasers: Introduction, **Stimulated absorption**, Spontaneous emission, Stimulated emission, Population Inversion, Laser principle, Einstein coefficients, Types of lasers: He-Ne laser, Ruby laser, Semiconductor laser, Applications of laser.

UNIT-V: OPTICAL FIBERS AND HOLOGRAPHY

(9 hrs)

Principle of Optical fibers, Acceptance angle, Acceptance cone, Numerical aperture, Types of optical fibers - Graded and Stepped index, **Types Signal attenuation mechanisms in optical fibers**, Applications of Optical fibers - Sensors, **Imaging**, Communication.

Holography: Basic principle of holography-Gabor hologram and its limitations, Applications of holography.

REFERENCE BOOKS:

1. BSc Physics Vol.1, Telugu Academy, Hyderabad.
2. Fundamentals of Physics. Halliday/Resnick/Walker, Wiley India Edition 2007.
3. Waves & Oscillations. S. Badami, V. Balasubramanian and K.R. Reddy, Orient Longman
4. BSc Physics, Vol .2, Telugu Academy, Hyderabad
5. A Text Book of Optics-N Subramanyam, L Brijlal, S. Chand & Co.
6. Unified Physics Vol. II Optics & Thermodynamics – Jai Prakash Nath & Co. Ltd., Meerut
7. Optics, F.A. Jenkins and H.G. White, Mc Graw-Hill 5. Optics, Ajay Ghatak, Tata Mc Graw-Hill. Introduction of Lasers – Avadhanulu, S. Chand & Co.
8. Principles of Optics- BK Mathur, Gopala Printing Press, 1995

SEMESTER-IV
Minor-Physics
COURSE 2: WAVES AND APPLIED OPTICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

This course provides students with a broad understanding of the physical principles of the oscillations, to help them develop critical thinking and aims to provide students with a fundamental understanding of the behavior and properties of light and its interaction with matter.

LEARNING OUTCOMES:

1. Perform experiments to analyze oscillatory systems and visualize resonance and damping.
2. Use optical instruments to study interference and polarization.
3. Measure the wavelength of light using Newton's rings and biprism methods.
4. Understand laser characteristics and fiber optic transmission through practical demonstration.
5. Record, analyze, and interpret experimental data with precision.

Minimum of 6 experiments to be done and recorded

1. Determination of 'g' by compound/bar pendulum
2. Simple pendulum normal distribution of errors-estimation of time period and the error of the mean by statistical analysis Verification of inverse square law of light using photovoltaic cell.
3. Determination of radius of curvature of a given convex lens-Newton's rings.
4. Resolving power of grating.
5. Study of optical rotation – polarimeter.
6. Dispersive power of a prism.
7. Determination of wavelength of light using diffraction grating-minimum deviation method.
8. Determination of wavelength of light using diffraction grating-normal incidence method.
9. Determination of thickness of a thin wire by wedge method
10. Refractive index of liquid using laser and rectangular container
11. Optical fiber - Numerical Aperture.

SEMESTER-III
Minor- Quantum Technologies
COURSE 1: FOUNDATIONS OF QUANTUM COMPUTING-
MATHEMATICAL AND PHYSICAL COMPUTING

TheoryCredits: 4

5 hrs/week

Course Outcomes

At the end of the course, students will be able to

CO1: Students will be able to compute eigenvalues, eigenvectors, and perform diagonalization of matrices, and interpret these results in the context of quantum state representation.

CO2: Students will be able to model random experiments using probability distributions and apply the Central Limit Theorem to analyze data relevant to quantum mechanical systems.

CO3: Students will be able to apply Maxwell's equations to derive wave propagation characteristics in free space, conducting media, and optical fibers.

CO4: Students will be able to trace the instruction execution cycle in a microprocessor, including fetch, decode, and execute phases, and explain the role of memory hierarchy in system performance.

CO5: Students will be able to design optimized combinational circuits such as adders, multiplexers, and code converters using Boolean algebra and Karnaugh map simplification.

Unit 1. Linear Algebra

Vectors and Vector Spaces, Linear Transformations, Complex Vectors and Matrices, Eigenvalues and Eigenvectors, Inner Product Spaces, Orthogonality and Hilbert Spaces, **Diagonalisation of Tensors**, Applications to Quantum Computing

Unit 2. Probability, Statistics and basics of Quantum Mechanics

Introduction to Statistics, Data Representation, Descriptive Statistics, Probability, Random Variables and Probability Distributions, Specific Probability Distributions and the Central Limit Theorem

Classical Mechanics Overview, Lagrangian Formulation, Hamiltonian Mechanics, Applications to Quantum Mechanics, Introduction to Electromagnetic theory, Maxwell's equations.

Unit 3. Computer Architecture

Digital Number Representation: Number systems: binary, octal, decimal, hexadecimal, Conversion between number systems, Signed number representation: sign-magnitude, 1's complement, 2's complement, Floating-point representation (IEEE 754 basics), Binary arithmetic (addition, subtraction, multiplication, division).

Computer Architecture Basics: Fundamentals of computer design, Functional units of a computer, Data path and control path, Input-Output organization

Instruction cycle: Fetch, Decode, Execute, Control unit.

Unit 4. Microprocessors and Memory

Microprocessor Fundamentals: Evolution of microprocessors (8085, 8086, Pentium, ARM), CPU internal architecture (ALU, registers, buses)., Addressing modes and instruction formats, Instruction execution and timing, Examples of simple assembly programs.

Memory Hierarchy: Need for memory hierarchy, Cache memory: mapping techniques and replacement policies, Main memory (RAM, ROM, DRAM, SRAM)., Virtual memory concepts (paging, segmentation), Secondary storage overview.

Unit 5. Digital Logic, Boolean Algebra, and Combinational Circuits

Introduction to Digital Logic Gates: Basic gates: AND, OR, NOT; universal gates: NAND, NOR, XOR, XNOR functions, Truth tables and circuit symbols, Logic gate implementations using transistors.

Boolean Algebra and Simplification: Boolean postulates and theorems, Canonical forms (SOP, POS), Simplification techniques: Boolean identities, algebraic manipulation, Karnaugh maps (2, 3, 4 variables).

Combinational Circuits: Half adder and full adder, Subtractors, comparators, Multiplexers, demultiplexers, Encoders, decoders, Design examples: Arithmetic circuits, code converters.

Textbooks:

1. Bernard Kolman, David A Hill, Elementary Linear Algebra with Applications, Pearson New International Edition, 2013.
2. Ron Larson, Elementary Statistics: Picturing the World, 8th Edition, Pearson, 2023.
3. Herbert Goldstein, Classical Mechanics, 3rd Edition, Addisen Wesley Publisher, 2001
4. Griffiths D. J., Introduction to Electrodynamics, 4th Edition, Cambridge University Press, 2020.
5. Thomas L. Floyd, Digital Fundamentals, 11th Edition, Pearson Publication, 2014.

Reference Books:

1. K. Hoffman and R. Kunze, Linear Algebra, Pearson Education, 2nd Edition, 2005.
2. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley India, 10th Edition, 2015.
3. David Morin, Introduction to Classical Mechanics, 1st Edition, Cambridge University, 2008.
4. William H. Hayt and John A. Buck, Engineering Electromagnetics, 8th Edition, McGraw-Hill Education, 2011.
5. David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 5th Edition, Morgan Kaufmann, 2013.

SEMESTER-IV

Minor-Quantum Technologies

COURSE 2: QUANTUM TECHNOLOGIES: PRINCIPLES AND APPLICATIONS

Theory

Credits: 4

5 hrs/week

Course Outcomes

At the end of the course, students will be able to

CO1: Understand foundational principles governing quantum behavior and contrast them with classical systems, study and interpret evolution and measurement of simple systems.

CO2: Analyze various physical platforms proposed or used for realizing advanced computing technologies.

CO3: Understand the principles behind high-precision measurement techniques enabled by quantum effects.

CO4: Apply coherence and entanglement concepts to real-world sensing applications in navigation and metrology.

CO5: Analyze communication systems using non-classical principles to enhance security and information transfer.

Unit 1: Introduction to Quantum Physics and Quantum Technologies

Motivation for Quantum Technologies, Quantum States, Wave functions, Probabilistic interpretation, Physical observables, Hermitian operators, Expectation values, Heisenberg uncertainty principle, Schrodinger equation, Time evolution, distinction from classical physics, Heuristic description of Superposition, Tunnelling and entanglement, No cloning theorem, Simulating classical systems – Feynman’s idea of a quantum simulator and the birth of the field.

Unit 2: Quantum Computation

Basics of Qubits, Superpositions, Entanglement, Measurement and Errors. Difference between classical bits and quantum Qubits, Review of classical logic gates, Di Vincenzo criteria for realizing qubits, Basics of Qubit gates and quantum circuits, overview of applications and recent achievements: RSA and Shor’s algorithm and Quantum Advantage.

Types of Qubits: Superconducting qubits, Photonic Qubits, Trapped Ions, and NV-centres for qubit generation.

Unit 3: Quantum Sensing

Basics of quantum sensing: Definition and scope, Classical vs. quantum sensing and Applications in precision measurements, navigation, and defense, Role of quantum coherence and entanglement in sensing; Principles of single-photon generation, Sources of single photons, Generation of entangled photon pairs. Quantum materials and their properties.

Atomic clock, magnetometry, state of the art in quantum sensing.

Unit 4: Quantum Communications

Basics of digital communication: Introduction to classical communication systems, Analog vs. digital communication, Encoding, modulation and transmission; Quantifying classical information: Definition and significance of entropy in communication and Shannon entropy; Quantum communication: Principles of quantum information transfer, Qubits in communication systems, Quantum superposition and entanglement in communication, Role of quantum states in secure information transfer;

Unit 5. Quantum Materials

(a) Introduction of Quantum materials: Semiconductors, superconductors and 2D Materials for Quantum Technology. Material growth Techniques: MBE, CVD and PLD (Qualitative introduction only)

(b) Quantum Simulators and Security

Running quantum protocols in a quantum simulator, implementing simple quantum algorithms on cloud-based quantum computers.

Security: Quantum Security and Eavesdropping: **No-cloning theorem** and secure communication, Detection of eavesdropping using quantum principles.

Textbooks

- 1.R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Springer, 2012.
- 2.Nouredine Zettili, Quantum Mechanics: Concepts and Applications, 2nd Edition, Wiley, 2009.
- 3.Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, 10th Anniversary Edition, Cambridge University Press, 2010.
- 4.David J. Griffiths and Darrell F. Schroeter, Introduction to Quantum Mechanics, 3rd Edition, Cambridge University Press, 2018.
- 5.Robert Eisberg and Robert Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition, Wiley, 1985.

Reference Books

- 1.J.J. Sakurai and Jim Napolitano, Modern Quantum Mechanics, 2nd Edition, Cambridge University Press, 2017.
- 2.Marlan O. Scully and M. Suhail Zubairy, Quantum Optics, 1st Edition, Cambridge University Press, 1997.
- 3.P. Hemmer, Quantum Technologies and Applications, 1st Edition, Springer, 2020.
- 4.Eleanor G. Rieffel and Wolfgang H. Polak, 1st Edition, MIT Press, 2011.
- 5.Mark M. Wilde, Quantum Information Theory, 2nd Edition, Cambridge University Press, 2017.

Multidisciplinary Course
SEMESTER-III
BASIC ELECTRONICS

Credits: 2

2 hrs/week

UNIT-I:

(10 hrs)

Brief History of Electronics, Overview of Atom and its particles, Voltage, Current & Resistance. Ohms Law, Series and Parallel Circuits, Short and Open circuit. Usage of Digital multimeter. Power Sources: DC and AC, Electrical energy, consumption of electrical power, Kilowatt hour (KWh). Batteries: How to Choose a Battery, types, lead acid batteries, Nickel – Cadmium, Lithium – Ion & Solar cell.

Identifying Phase, Neutral and Earth on power sockets, Electric tester, First aid for electric shock. Basics of House wiring, Overloading, electrical circuit protection using Fuses, MCBs, earthing and its necessity, awareness of electrical safety tools.

UNIT-II:

(10 hrs)

Classification of solids according to electrical conductivity (Conductor, Semiconductor & Insulator). Intrinsic & Extrinsic Semiconductors. Vacuum Tubes, Diodes, Transistors, ICs & Relays: advantages, disadvantages, applications, and their uses. Transducers and Sensors: Advantages, various parts, types, and applications, LED, IR LED, Photo Resistor & Photodiode (Symbol & applications of each)

DC Regulated Power Supply, IC Voltage Regulators, UPS

Home Appliances: Electric geyser, micro wave oven and refrigerator

UNIT-III:

(10 hrs)

Basics of Communication Systems: Transmitter, Receiver, Channel i) wired channels ii) wireless channels, Modulation, Demodulation.

Daily usage of Electronic Devices include: Mobile phones, Digital Camera, audio & video systems, TV (Television), Computer, Laptop, LED lights, GPS, iPod and Tablets, Wi-Fi and Internet. Importance of energy efficiency in electrical appliances.

Electronics in different fields: Information processing, Medicine and research, Computers and other electronic instruments, Automation.

Resource Material

(1) Electrical technology by V.K. Mehta & Rohit Mehta (S. Chand & Company Pubs.)

(2) Few references from Wikipedia free Encyclopedia.

Multidisciplinary Course

SEMESTER-IV

INTRODUCTION TO NANOTECHNOLOGY

Credits: 2

2 hrs/week

Course Objective:

The objective of the course "Introduction to Nanotechnology" is to provide students with a comprehensive understanding of the principles, applications, and implications of nanotechnology from a multidisciplinary perspective.

Programme Outcomes:

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

1. Define and describe the fundamentals of nanotechnology: Students will develop a clear understanding of the basic concepts and principles of nanotechnology, including nanoscale materials, structures, and phenomena. They will grasp the unique properties and behavior of materials at the nanoscale and how they differ from macroscopic systems.
2. Understand the fabrication and characterization techniques in nanotechnology: Students will learn about the techniques and tools used to fabricate, manipulate, and characterize nanoscale materials and devices. They will explore techniques such as lithography, self-assembly, microscopy, spectroscopy, and nanofabrication methods.
3. Evaluate the ethical and societal implications of nanotechnology: Students will critically assess the ethical, social, and environmental implications of nanotechnology. They will explore issues related to privacy, health and safety, sustainability, and public perception, enabling them to make informed judgments and decisions regarding the responsible development and deployment of nanotechnology.

Syllabus:

Unit 1: Introduction to Nanotechnology

Overview of Nanotechnology: Definition, scope, and interdisciplinary nature of nanotechnology. Historical Development: Understanding the historical background and key milestones in the field of nanotechnology. Nanoscale Science: Introduction to the unique properties and phenomena at the nanoscale, including quantum effects and surface-to-volume ratio. Nanotechnology Applications: Exploring the diverse range of applications of nanotechnology in various fields such as medicine, electronics, energy, and materials science.

Unit 2: Nanomaterials and Fabrication Techniques

Nanomaterials: Introduction to different types of nanomaterials, including nanoparticles, nanotubes, and nanocomposites. Understanding their synthesis, characterization, and properties. Top-Down Fabrication: Exploring top-down fabrication techniques, such as lithography and etching, used to create nanostructures and devices. Bottom-Up Fabrication: Introduction to bottom-up fabrication techniques, such as self-assembly and molecular nanotechnology, for the creation of nanoscale structures. Characterization Techniques: Overview of characterization techniques used to analyse and measure nanomaterials, including microscopy, spectroscopy, and diffraction methods.

Unit 3: Implications and Ethics of Nanotechnology

Environmental and Health Impacts: Understanding the potential environmental and health impacts of nanotechnology, including the risks associated with nanoparticles and nanomaterials. **Ethical Considerations:** Exploring ethical considerations related to nanotechnology, including privacy concerns, responsible research, and societal implications. **Regulatory Framework:** Introduction to the regulatory frameworks and safety standards for the development and commercialization of nanotechnology products. **Future Perspectives:** Discussing emerging trends, challenges, and future prospects in the field of nanotechnology, including advancements in nanomedicine, nanoelectronics, and nanomanufacturing.

Reference Books:

1. "Introduction to Nanotechnology" by Charles P. Poole Jr. and Frank J. Owens: This book provides a comprehensive introduction to the field of nanotechnology. It covers the basics of nanoscale science and engineering, fabrication techniques, nanomaterials, and various applications of nanotechnology.
2. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Prakash C. Ghosh: This book offers an overview of the principles and applications of nanotechnology. It covers nanomaterials, nanofabrication methods, characterization techniques, and the role of nanotechnology in different sectors such as electronics, medicine, energy, and environmental remediation.
3. "Introduction to Nanoscience and Nanotechnology" by Gabor L. Hornyak, Joydeep Dutta, et al.: This textbook provides a comprehensive introduction to nanoscience and nanotechnology. It covers the fundamental concepts, fabrication techniques, characterization methods, and applications of nanotechnology. It also discusses societal and ethical considerations related to nanotechnology.
4. "Nanotechnology: Basic Science and Emerging Technologies" by Mick Wilson, Kamali Kannangara, et al.: This book presents the fundamental concepts and emerging technologies in nanotechnology. It covers nanoscale physics, chemistry, materials science, and engineering aspects of nanotechnology. It also explores the potential impact of nanotechnology on various fields, including medicine, electronics, and energy.
5. "Introduction to Nanotechnology" by Poole and Owens: This introductory textbook covers the basics of nanotechnology, including nanoscale phenomena, nanomaterials, fabrication techniques, and applications in electronics, medicine, and energy. It provides a solid foundation for understanding the principles and potential of nanotechnology.

Justification Proforma for Amendments in the syllabus for Semester III & IV 2026-27

S.No.	Semester	Paper	Title of the Paper	Major Additions/Deletions		Justification
1	III	Course 6	Basic electronics	Unit-I	Deletion: Series and parallel combinations: Equivalent resistance/capacitance/inductance	Topics already covered in Intermediate
				Unit -II	Addition: Zener diode as Voltage regulator	As an application for the topic
		Course 7	Applied optics	Unit III	Addition: Stimulated absorption	Required for study of lasers
				Unit IV	Deletion: Types of Signal attenuation mechanisms in optical fibers & Imaging	Topic is beyond UG context
				Unit V	Addition: Simple microscope & TEM Deletion: Confocal microscope, Solar telescope & Infrared telescope	Topics removed due to excess workload per unit
2	IV	Course 9	Analog electronics	Practical	Addition: Studying sine wave characteristics (amplitude, frequency, time period) using CRO	Experiment added for gaining additional knowledge
		Course 10	Advances in Physics	Unit II	Deletion: Legendre transformation	Topics removed due to excess workload per unit
				Unit V	Deletion: Fuel cells	Topic is irrelevant

PHYSICS MINOR:

S.No.	Semester	Paper	Title of the Paper	Major Additions/Deletions		Justification
1	III	Course 1	Mechanics and Properties of matter	Unit-IV	Deletion: Venturimeter	Topics removed due to excess workload per unit
2	IV	Course 2	Waves and Applied Optics	Unit IV	Addition: Stimulated absorption	Required for study of lasers
				Unit V	Deletion: Types Signal attenuation mechanisms in optical fibers & Imaging	Topic is beyond UG context

ANNEXURE - III

CLUSTER UNIVERSITY: KURNOOL

DEPARTMENT Of PHYSICS

II B.Sc. Physics W.e.f. 2026-2027

SEMESTER-III

Course-C5: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

MODEL QUESTION PAPER

Time:3hrs

Max.Marks:70

SECTION-A

Answer any **FIVE** of the following Questions

5 x 4M = 20M

1. Explain Vector atom model
2. Explain coupling schemes.
3. Explain molecular rotational spectra.
4. Explain de Broglie hypothesis of matter waves.
5. Explain mass defect and binding energy.
6. Define nuclear forces. Explain their characteristics.
7. Explain classification of elementary particles.
8. Explain strong, electromagnetic and weak interactions.

Note: Two questions from each unit-I, IV, V and One from each Unit-II &III

SECTION-B

Answer **ALL** Questions

5 x 10M = 50M

9. (a) Explain the Quantum numbers associated with vector atom model.

OR

(b)) Explain Stern – Gerlach experiment with necessary theory.

10. (a) Explain the experimental arrangement of Raman effect and its characteristics

OR

(b) Explain the quantum theory of Raman effect and its applications.

11. (a) Describe Davisson and Germer experiment with a neat diagram

OR

(b) Explain Heisenberg's uncertainty principle and illustrate it using single slit.

12. (a) Explain Liquid drop model and semi empirical mass formula

OR

(b) Describe how shell model explains magic numbers

13. (a) Explain the construction and working of Cyclotron

OR

(b) Explain the construction and working of Geiger – Muller counter.

CLUSTER UNIVERSITY: KURNOOL
DEPARTMENT Of PHYSICS
II B.Sc. Physics W.e.f. 2026-2027
SEMESTER-III
Course-C6 : BASIC ELECTRONICS
MODEL QUESTION PAPER

Time:3hrs

Max.Marks:70

SECTION-A

Answer any **FIVE** of the following Questions

5 x 4M = 20M

1. State Ohm's Law. A resistor of $10\ \Omega$ is connected across a 20 V supply.
Calculate the current flowing through the resistor.
2. Write the differences between Intrinsic and extrinsic semiconductors.
3. Explain the current components of NPN transistor.
4. Explain the working of a Half wave rectifier.
5. Compare analog Vs digital signals.
6. Convert the binary number 101101 to i) decimal and ii) hexadecimal
7. Write about the need for DC power supply.
8. Write the uses of special diodes.

Note: Two questions from each unit-II, IV, V and One from each Unit-I & III

SECTION-B

Answer **ALL** Questions

5 x 10M = 50M

9. (a) State and Explain i) Kirchhoff's Current law and ii) Kirchhoff's voltage law

OR

(b)) Explain the construction, characteristics, and applications of ceramic, electrolytic, and film capacitors.

10. (a) Explain the construction and working of PN junction diode.

OR

(b) Explain the construction and working of Solar cell and write its applications

11. (a) Describe input and output characteristics of a transistor in CE configuration

OR

(b) Explain the applications of transistor as a i) Switch & ii) Amplifier

12. (a) Explain the working of a Full wave bridge rectifier along with wave forms

OR

(b) Describe RC, LC and π filters

13. (a) Explain basic logic gates along with truth tables

OR

(b) State and explain De Morgan's theorems.

CLUSTER UNIVERSITY: KURNOOL
DEPARTMENT Of PHYSICS
II B.Sc. Physics W.e.f. 2026-2027 SEMESTER- III
Course-C7 : Applied Optics
MODEL QUESTION PAPER

Time:3hrs

Max.Marks:70

SECTION-A

Answer any **FIVE** of the following Questions

5 x 4M = 20M

1. Write the reflection, translation and refraction matrices.
2. Explain i) Coma & ii) Astigmatism.
3. Write the applications of Laser.
4. Explain Numerical aperture.
5. Write a note on compound microscope.
6. Explain Curvature of field.
7. Write the applications of optical fibers.
8. Write the applications of microscopes.

Note: Two questions from each unit-II, IV, V and One from each Unit-I & III

SECTION-B

Answer **ALL** Questions

5 x 10M = 50M

9. (a) Explain the construction and working of Ramsden eyepiece.

OR

(b) Derive the two-lens formula for lenses separated by a distance. Calculate f , given $f_1 = 10$ cm, $f_2 = 20$ cm and $d = 5$ cm in air.

10. (a) Derive the condition for chromatic aberration and explain how an achromatic doublet corrects it.

OR

(b) Derive the condition for achromatism for two lenses separated by a distance.

11. (a) Explain the construction and working of Ruby laser.

OR

(b) Explain Einstein's coefficients.

12. (a) Explain the i) Graded index and ii) Step index fibers

OR

(b) Describe Gabor hologram and write its limitations.

13. (a) Explain construction and working of Scanning electron microscope (SEM).

OR

(b) Explain the construction and working of Radio telescope.

CLUSTER UNIVERSITY: KURNOOL

MODEL QUESTION PAPER (Physics Major)

Course 8: Electricity, Magnetism & Electromagnetic theory (w.e.f. 2026-27)

Semester – IV

Time: 3 Hrs

Max. Marks: 70M

PART-A

I. Answer FIVE questions. Each question carries 4 marks.

5QX 4M = 20M.

1. Define Dielectric constant and Electric susceptibility & obtain the relation between them.
2. What are Equipotential surfaces? Give examples.
3. Define Ohm's Law and give its limitations.
4. State and Explain Biot-Savart's Law.
5. Explain Lenz's law.
6. Derive Continuity equation.
7. Write brief note on LCR tuning circuit.
8. Obtain an expression for Power in ac circuits.

(Two questions from Unit I, III, V and One from each unit II & IV)

PART-B

II. Answer ALL questions. Each question carries 10 marks.

5QX10M = 50M

9.(a) State Gauss's Law. Using Gauss law derive an expression for the Electric field due to uniformly charged sphere.

OR

(b) Define the three electric vectors D, E & P and derive relation between them.

10.(a) State and prove Thevenin's and Norton's theorems in electric circuits.

OR

(b) Explain Star to Delta & Delta to Star conversions.

11.(a) What is Hall Effect? Obtain an expression for Hall Coefficient.

OR

(b) Define self-induction & Mutual inductance. Derive expression for the self-inductance of a long solenoid.

12.(a) Derive the wave equation for electromagnetic waves using Maxwell's equations.

OR

(b) Describe Hertz experiment for the production and detection of electromagnetic waves

13(a) Discuss LCR Series resonant circuit and obtain expression for its resonant frequency.

OR

(b) Obtain the relation between voltage & current in LR circuit.

(Set ONE question from each Unit-I, II, III, IV, V with internal choice)

CLUSTER UNIVERSITY: KURNOOL
MODEL QUESTION PAPER (Physics Major)
Course 9: ANALOG ELECTRONICS (w.e.f. 2026-27)

Semester – IV

Time: 3 Hrs

Max. Marks: 70M

PART-A

I. Answer FIVE questions. Each question carries 4 marks.

5QX 4M = 20M.

1. Define load line analysis. What is its significance in transistor amplifiers?
2. Compare fixed bias and voltage divider bias methods.
3. What is negative feedback? Mention its advantages.
4. What are the characteristics of an ideal operational amplifier?
5. Draw the pin configuration of IC 741.
6. Explain the concept of virtual ground in an operational amplifier.
7. State Barkhausen criterion for oscillations.
8. What are the advantages of a crystal oscillator.

(Two questions from Unit I, III, V and One from each unit II & IV)

PART-B

II. Answer ALL questions. Each question carries 10 marks 5QX10M = 50M

- 9.(a) Explain the CE amplifier circuit. Derive expressions for voltage gain, input impedance, and output impedance.

OR

- (b) Describe multistage amplifiers and explain the working, characteristics, and applications of an emitter follower (voltage follower).

- 10.(a) Explain the construction, working, efficiency, advantages, and disadvantages of Class A power amplifier.

OR

- (b) Describe the working of a push-pull amplifier with neat circuit diagram and waveforms. Discuss its merits and demerits.

11. (a) Explain the following op-amp parameters: (i) CMRR (ii) Slew Rate
(iii) Input Offset Voltage (iv) Input Bias Current

OR

- (b) Explain open-loop configurations of an operational amplifier with suitable Circuit diagram and write its applications.

12. (a) Explain the construction and working of (a) Adder (b) Subtractor

OR

- (b) Explain the design, working, and applications of: (i) Integrator

- 13.(a) Explain the construction, working, frequency of oscillation, advantages, and of RC Phase Shift Oscillator.

OR

- (b) Explain the construction, working, frequency of oscillation, and applications of Hartley oscillator.

CLUSTER UNIVERSITY: KURNOOL
DEPARTMENT Of PHYSICS
II B.Sc. Physics W.e.f.2026-2027
SEMESTER-IV
Course-10: ADVANCES IN PHYSICS
MODEL QUESTION PAPER

Time:3hrs

Max.Marks:70

Section - A

Answer any **FIVE** of the following Questions

5x4M=20M

1. Explain the postulates of Quantum mechanics
2. Explain the principle of virtual work
3. Explain the principle of least action
4. Explain Moore's law and its limitations
5. Explain the historical development of Nano technology
6. Write the applications of Nano technology
7. Discuss the difference between conventional and non-conventional energy sources.
8. Explain Renewable energy and its resources

Note: Two questions from each unit-II, IV, V and One from each Unit-I & III

Section - B

Answer ALL Questions

5x10M=50M

- 9.(a) Derive Schrodinger time independent wave equation.

OR

- (b) Derive equation for Energy values of one dimensional particle in a box

- 10 (a) Derive Lagranges equation of motion

OR

- (b) Describe the application of simple pendulum using Lagranges equation of motion.

11. (a) Explain Shor's and Grover's algorithm

OR

- (b) Explain the generation of computers

- 12.(a) Explain Nano tubes and nano wires

OR

- (b) Explain volume to surface ration and quantum effects of nano materials.

- 13.(a) Explain Solar energy and its generation and energy storage.

OR

- (b) Explain Wind energy, Biomass energy, Tidal energy

Note: (Set One question from each Unit-I, II, III, IV)

CLUSTER UNIVERSITY: KURNOOL
MODEL QUESTION PAPER (Physics Minor)
Course 1: Mechanics and Properties of matter

(w.e.f. 2026-27)

Semester – III

Time: 3 Hrs

Max. Marks: 70M

PART-A

Answer FIVE questions. Each question carries 4 marks.

5QX 4M = 20M.

1. Explain Newtons laws of motion.
2. Define Collision. Distinguish between elastic and inelastic collisions.
3. Define central force and write its characteristics.
4. Discuss briefly motion of satellites and Geostationary satellite.
5. Explain different types of bending in beams.
6. Define the terms i)Stress ii) Strain iii)Hooks law iv)Poisson's Ratio.
7. State and explain Poiseuille's law in Viscosity.
8. Deduce Einsteins Mass Energy Relation.

(Two questions from each Unit I,II, III and One from each unit IV &V)

PART-B

Answer ALL questions. Each question carries 10 marks.

5QX10M = 50M

- 9.(a) Discuss the motion of Variable mass system. Derive an expression for final velocity of Rocket.

OR

- (b) Define the terms impact parameter and Scattering angle in Rutherford's scattering and derive the relation between them

- 10.(a) Define Conservative force and show that the central force is conservative.

OR

- (b) State Kepler's laws. Deduce Kepler's first law.

- 11.(a) Define the three elastic moduli and derive the relation between them.

OR

- (b) Explain the working principle of torsional pendulum. What are its uses.

- 12.(a) Discuss the classification of fluids based on their properties. Water flows through a pipe with an internal diameter of 2cm at a velocity of 1m/s. the pipe is connected to a nozzle with a smaller diameter. What is the diameter of nozzle if the water exits at a speed of 4m/s?

OR

- (b) State and prove Bernoulli's Principle. Explain one application.

- 13.(a) Describe Michelson's Morley Experiment. What is the significance of the experiment?

OR

- (b) State the postulates of special theory of relativity. Derive Lorentz transformation equations.

(Set ONE question from each Unit-I, II, III ,IV, V with internal choice)

CLUSTER UNIVERSITY: KURNOOL
MODEL QUESTION PAPER (Physics Minor)

Course 2: WAVES AND APPLIED OPTICS (w.e.f. 2026-27)
Semester – IV

Time: 3 Hrs

Max. Marks: 70M

PART-A

I. Answer FIVE questions. Each question carries 4 marks.

5QX 4M = 20M.

1. Define Simple Harmonic Motion (SHM). What are its physical characteristics?
2. Define logarithmic decrement and quality factor.
3. State the conditions necessary for sustained interference.
4. Explain Brewster's law.
5. Differentiate between quarter-wave plate and half-wave plate.
6. Define stimulated emission and spontaneous emission.
7. Distinguish between step-index and graded-index optical fibers.
8. State the basic principle of holography.

PART-B

II. Answer ALL questions. Each question carries 10 marks

5QX10M = 50M

- 9.(a) Explain the combination of two mutually perpendicular SHMs having Different frequencies. Draw the corresponding Lissajous figures.

OR

- (b) Derive the differential equation of a damped harmonic oscillator. Discuss it's solution.

- 10.(a) Explain Fresnel's biprism experiment for the determination of the wavelength of monochromatic light.

OR

- (b) Explain Newton's Rings experiment in reflected light. Describe the method for determining the wavelength of monochromatic light.

- 11.(a) Explain the construction, working, and applications of Nicol prism as a polarizer and analyser.

OR

- (b) Explain optical activity and describe the determination of specific rotation using Laurent's Half Shade Polarimeter.

- 12.(a) Derive Einstein coefficients and explain their significance in laser action.

OR

- (b) Explain the construction, working, energy level diagram, and applications of Ruby Laser.

- 13.(a) Explain the principle of optical fiber communication. Derive the expressions for acceptance angle, acceptance cone, and numerical aperture.

OR

- (b) Discuss various signal attenuation mechanisms in optical fibers.

CLUSTER UNIVERSITY: KURNOOL
Minor: QUANTUM TECHNOLOGIES
Course 1: FOUNDATIONS OF QUANTUM COMPUTING-
MATHEMATICAL AND PHYSICAL COMPUTING
(w.e.f. 2026-27)

MODEL QUESTION PAPER

Semester – III

Time: 3 Hrs

Max. Marks: 70M

PART-A

Answer FIVE questions. Each question carries 4 marks.

5Q X 4M = 20M.

1. Explain the concepts of vector spaces and linear transformations with suitable examples.
2. Define eigenvalues and eigenvectors. Explain their importance in quantum computing.
3. Explain the properties of inner product spaces and orthogonality. What is a Hilbert space?
4. Define random variables and probability distributions. Differentiate between discrete and continuous probability distributions with examples.
5. Explain the Lagrangian and Hamiltonian formulations of classical mechanics. State their significance in quantum mechanics.
6. Explain the IEEE 754 floating-point representation with a suitable example. Discuss its advantages over fixed-point representation.
7. Describe the fetch–decode–execute instruction cycle with a neat block diagram.
8. Explain the need for memory hierarchy. Differentiate between cache memory, RAM, ROM, and virtual memory.

PART-B

Answer ALL questions. Each question carries 10 marks.

5QX10M = 50M

- 9.(a) Discuss complex vectors and matrices. Explain their applications in quantum computing.

OR

(b) Explain eigenvalues, eigenvectors, inner product spaces, orthogonality, Hilbert spaces, and diagonalization of tensors. Discuss their applications in quantum computation.

- 10.(a) Discuss probability, random variables, probability distributions, specific probability distributions, and the Central Limit Theorem with suitable examples.

OR

(b) Explain the Lagrangian and Hamiltonian formulations of classical mechanics. Discuss their applications in quantum mechanics.

- 11.(a) Explain various digital number systems. Discuss conversions between binary, octal, decimal, and hexadecimal number systems.

OR

(b) Explain the architecture of a digital computer with a neat block diagram. Discuss the functional units, data path, control path, input-output organization,

12. (a) Discuss the evolution of microprocessors from 8085 to ARM processors. Explain the CPU architecture, addressing modes.

(b) Explain the concept of memory hierarchy. Discuss cache memory organization,

13. (a) Explain the basic logic gates and universal gates with truth tables.

OR

(b) Explain the design and operation of combinational circuits including half adder and full adder.

CLUSTER UNIVERSITY
Minor-QUANTUM TECHNOLOGIES

Course 2: QUANTUM TECHNOLOGIES: PRINCIPLES AND APPLICATIONS (w.e.f. 2026-27)

MODEL QUESTION PAPER

Semester – IV

Time: 3 Hrs

Max. Marks: 70M

PART-A

Answer FIVE questions. Each question carries 4 marks.

5Q X 4M = 20M.

1. Define a quantum state. How does it differ from a classical state?
2. State the Heisenberg Uncertainty Principle and explain its significance.
3. What is the principle of quantum superposition?
4. Differentiate between a classical bit and a quantum bit (qubit).
5. State the DiVincenzo criteria for realizing qubits.
6. What is quantum sensing? Mention any two practical applications.
7. Define Shannon entropy and explain its importance in communication systems.
8. Write short note on Quantum Materials.

PART-B

Answer ALL questions. Each question carries 10 marks.

5QX10M = 50M

9.(a) Explain the postulates of quantum mechanics. Explain in detail about Hermitian operators, expectation values, and the Schrödinger equation

OR

(b) Describe the fundamental differences between classical physics and quantum physics. Explain the concepts of superposition and entanglement.

10.(a) Explain the concept of qubits and quantum computation. Compare classical logic gates with quantum gates.

OR

(b) Explain the working principles, advantages, and limitations of superconducting qubits.

11.(a) Explain the principles of quantum sensing. Discuss the role of quantum coherence and entanglement in precision measurements.

OR

(b) Describe the principles of single-photon generation and entangled photon pair generation. Explain the operation and applications of atomic clocks.

12. (a) Explain the fundamentals of classical digital communication systems. Discuss about Shannon entropy.

(b) Explain the principles of quantum communication. Discuss quantum information transfer, quantum superposition, and secure communication using quantum states.

13. (a) Discuss the importance of semiconductor, superconductor, and two-dimensional (2D) quantum materials in quantum technologies.

OR

(b) Explain the implementation of simple quantum algorithms using cloud-based quantum computers. Discuss the role of quantum simulators.

CLUSTER UNIVERSITY, KURNOOL
MODEL QUESTION PAPER

MDC -Course 1: Basic Electronics (w.e.f. 2026-27)

Semester – III

Time: 2 Hrs

Max. Marks: 50M

PART-A

I. Answer any FIVE questions. Each question carries 4 marks.

5QX 4M = 20M.

1. Define voltage, current, and resistance. Mention their units and measuring instruments.
2. Differentiate between series and parallel circuits with suitable diagrams.
3. Explain the necessity of earthing in electrical installations.
4. Classify solids based on electrical conductivity. Explain conductors, semiconductors, and insulators with examples.
5. Write short notes on IR LED and its applications.
6. Explain the construction, symbol, and applications of a photodiode
7. What is GPS? Explain its working and applications.
8. Explain the role of the Internet in modern communication.

PART-B

II. Answer any THREE questions. Each question carries 10 marks.

3QX10M = 30M

9. Explain the differences between AC and DC power supplies. Discuss electrical energy, power, and the calculation of energy consumption in kWh with suitable examples.
10. Describe the functions of Phase, Neutral, and Earth wires, and explain how they are identified using an electric tester.
11. Explain the classification of solids based on electrical conductivity. Discuss intrinsic and extrinsic semiconductors with neat diagrams and suitable examples.
12. Explain the construction and working of a UPS with a neat block diagram. Discuss its types, advantages, and applications
13. Draw the block diagram of a basic communication system and explain the functions of the transmitter, communication channel, and receiver.

CLUSTER UNIVERSITY: KURNOOL
DEPARTMENT OF PHYSICS
II B.Sc. Physics W.e.f.2026-2027
SEMESTER - IV
MULTI DISCIPLINARY COURSE: INTRODUCTION TO NANO TECHNOLOGY
MODEL QUESTION PAPER

Time:2hrs

Max.Marks:50

Section - A

Answer any **FOUR** of the following Questions

5x4M=20M

1. Explain the historical background and key milestones in the field of nanotechnology.
2. Explain applications of Nano technology
3. Explain different types of nano materials
4. Explain the characterization techniques used to analyze and measure nano materials
5. Explain the potential environmental and health impacts of nanotechnology
6. Explain ethical considerations related to nano technology.

Section - B

Answer ALL Questions

3x10M=30M

- 7.(a) Explain the unique properties and phenomena at the nanoscale, including quantum effects and surface-to-volume ratio

OR

- (b) Explain the Definition, scope, and interdisciplinary nature of nanotechnology

- 8 (a) Explain top down fabrication techniques

OR

- (b) Explain Bottom up fabrication techniques.

- 9 (a) Discuss the emerging trends, challenges, and future prospects in the field of nanotechnology

OR

- (b) Explain the Regulatory Framework: Introduction to the regulatory frameworks and safety standards for the development and commercialization of nanotechnology products

Practical's Scheme of Valuation

Time: 3hrs

Max.Marks:50M

1. Formulae & Explanation	-	05 Marks
2. Tabular form + graph/ circuit diagram	-	10 Marks
3. Observations	-	10 Marks
4. Calculation, Graph, Precaution and Result	-	10 Marks
5. Viva voce	-	05 Marks
6. Record	-	10 Marks

Total Marks	-	50 Marks
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ANNEXURE-V

INTERNAL ASSESSMENT

Continuous internal assessment is done on a regular basis to know the progress of the students. It facilitates the teacher to take necessary remedial activities for slow learners and to encourage the bright students by giving challenging tasks. Out of 30 marks, 20 marks are allotted for internal assessment exam and 5 marks for assignment, and 5 marks for seminar. Two mid internal objective tests will be conducted either in offline/ online mode and the average will be taken.

For I year students internal assessment will be done for 30 marks

Type of Evaluation	Written exam		Total	Seminar /viva voce	Assignment	Grand Total
	I internal	II internal				
Marks Allotment	20	20	20 (Average of I & II internal exams)	5	5	30

ANNEXURE - VI

CLUSTER UNIVERSITY: KURNOOL

Panel of Paper Setters

1. Dr H Sudhakara Rao Lecturer in Physics Govt. Degree College, Rajamundry Kadapa 9884770142.	2. Dr A Durga Lakshmi Lecturer in Physics Govt. Degree College, Rajamundry 9491419667
3. Dr J Chandrasekhar Lecturer in Physics SCNR Govt Degree College Proddatur.7382105240	4. Dr.S.Abdul Muneer Lecturer in Physics Osmania College Kurnool Kurnool District.9849747351
5. Dr. A. Lokeswara Reddy Lecturer in Physics Government Degree College for men, Kadapa -9440843490	6 Dr K.A Jamal Basha Lecturer in Physics Govt. College for Men(A) Kadapa 9441549098
7. Dr M. Sarada Lecturer in Physics, GDC Nandikotkur Kurnool 9908056520	8. Dr. S. Nisar Ahmed Lecturer in Physics Osmania College Kurnool Kurnool Dist. 9700382288
9. Smt A Sasikala Lecturer in Physics Government Degree College, Nandyal	10 Smt. S. Vasavi Devi Lecturer in Physics Govt. Degree College Nandyal 9515507034
11 Dr.T.Gopal Reddy Lecturer in Physics Balasiva Degree College, Kurnool Kurnool 9440672512	12 Dr G Madhusudhan Lecturer in Physics Govt. Degree College Anantapur. 9515962917
13 Dr. T. Raghuram, Lecturer in Physics, Government Degree College Puttur - 7396650368	14 Dr D Chandrasekhar Lecturer in Physics SVGM Govt Degree College Kalyandurg, Anantapur Dist 9491546997
15. Dr. Altaf Ahmed Associate Professor of Physics Balasiva Degree College, Kurnool 9440292987	15. Dr. T Firoz Khan Associate Professor of Physics Govt College Anantapur(A) 9441551587