



Programme: B.Sc. Honours in Physics (Major)

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
I	I	1	Essentials and Applications of Mathematical, Physical and Chemical Sciences	3+2	4
		2	Advances in Mathematical, Physical and Chemical Sciences	3+2	4
	II	3	Mechanics and Properties of Matter	3	3
			Mechanics and Properties of Matter Practical Course	2	1
		4	Waves and Oscillations	3	3
			Waves and Oscillations Practical Course	2	1
II	III	5	Optics	3	3
			Optics Practical Course	2	1
		6	Heat and Thermodynamics	3	3
			Heat and Thermodynamics Practical Course	2	1
		7	Electronic Devices and Circuits	3	3
			Electronic Devices and Circuits Practical Course	2	1
		8	Analog and Digital Electronics	3	3
			Analog and Digital Electronics Practical course	2	1
	IV	9	Electricity and Magnetism	3	3
			Electricity and Magnetism Practical Course	2	1
		10	Modern Physics	3	3
			Modern Physics Practical Course	2	1
		11	Introduction to Nuclear and Particle Physics	3	3
			Introduction to Nuclear and Particle Physics Practical Course	2	1



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM
Single Major B.Sc. Physics (w.e.f:2023-24A.B)

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
III	V	12	Applications of Electricity And Magnetism	3	3
			Applications of Electricity And Magnetism Practical Course	2	1
		13	Electronic Instrumentation	3	3
			Electronic Instrumentation Practical Course	2	1
		14 A	Optical Instruments and Optometry	3	3
			Optical Instruments and Optometry Practical Course	2	1
		OR			
		14 B	Optical Imaging and Photography	3	3
			Optical Imaging and Photography Practical Course	2	1
		15 A	Low Temperature Physics & Refrigeration	3	3
			Low Temperature Physics & Refrigeration Practical Course	2	1
		OR			
		15 B	Solar Energy and Applications	3	3
			Solar Energy and Applications Practical Course	2	1
	VI	Internship			
	VII		Courses will be available in due course of time		
	VIII		Courses will be available in due course of time		

Design a code converter circuit: Students can be asked to design and build a code converter circuit that converts a binary code to another code, such as Gray code, BCD, or ASCII. They can use logic gates, multiplexers, and decoders to implement the circuit, and test its operation by inputting different codes



SEMESTER-I

**COURSE 1: ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL
AND CHEMICAL SCIENCES**

Theory

Credits: 4

5 hrs/week

Course Objective:

The objective of this course is to provide students with a comprehensive understanding of the essential concepts and applications of mathematical, physical, and chemical sciences. The course aims to develop students' critical thinking, problem-solving, and analytical skills in these areas, enabling them to apply scientific principles to real-world situations.

Learning outcomes:

1. Apply critical thinking skills to solve complex problems involving complex numbers, trigonometric ratios, vectors, and statistical measures.
2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations
3. To Explain the basic principles and concepts underlying a broad range of fundamental areas of chemistry and to Connect their knowledge of chemistry to daily life.
4. Understand the interplay and connections between mathematics, physics, and chemistry in various applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.

5 To explore the history and evolution of the Internet and to gain an understanding of network security concepts, including threats, vulnerabilities, and countermeasures.

UNIT I: ESSENTIALS OF MATHEMATICS:

Complex Numbers: Introduction of the new symbol i – General form of a complex number – Modulus-Amplitude form and conversions

Trigonometric Ratios: Trigonometric Ratios and their relations – Problems on calculation of angles

Vectors: Definition of vector addition – Cartesian form – Scalar and vector product

and problems **Statistical Measures:** Mean, Median, Mode of a data and problems

UNIT II: ESSENTIALS OF PHYSICS:

Definition and Scope of Physics- Measurements and Units - Motion of objects: Newtonian Mechanics and relativistic mechanics perspective - Laws of Thermodynamics and Significance- Acoustic waves and electromagnetic waves- Electric and Magnetic fields and their interactions- Behaviour of atomic and nuclear particles- Wave-particle duality, the uncertainty principle- Theories and understanding of universe



UNIT III: ESSENTIALS OF CHEMISTRY:

Definition and Scope of Chemistry- Importance of Chemistry in daily life -Branches of chemistry and significance- Periodic Table- Electronic Configuration, chemical changes, classification of matter, Biomolecules- carbohydrates, proteins, fats and vitamins.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY:

Applications of Mathematics in Physics & Chemistry: Calculus, Differential Equations & Complex Analysis

Application of Physics in Industry and Technology: Electronics and Semiconductor Industry, Robotics and Automation, Automotive and Aerospace Industries, Quality Control and Instrumentation, Environmental Monitoring and Sustainable Technologies.

Application of Chemistry in Industry and Technology: Chemical Manufacturing, Pharmaceuticals and Drug Discovery, Materials Science, Food and Beverage Industry.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

Milestones of computer evolution - Internet, history, Internet Service Providers, Types of Networks, IP, Domain Name Services, applications.

Ethical and social implications: Network and security concepts- Information Assurance Fundamentals, Cryptography-Symmetric and Asymmetric, Malware, Firewalls, Fraud Techniques- Privacy and Data Protection

Recommended books:

1. Functions of one complex variable by John.B.Conway, Springer- Verlag.
2. Elementary Trigonometry by H.S.Hall and S.R.Knight
3. Vector Algebra by A.R.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. Basic Statistics by B.L.Agarwal, New age international Publishers
5. University Physics with Modern Physics by Hugh D. Young and Roger A. Freedman
6. Fundamentals of Physics by David Halliday, Robert Resnick, and Jearl Walker
7. Physics for Scientists and Engineers with Modern Physics" by Raymond A. Serway and John W. Jewett Jr.
8. Physics for Technology and Engineering" by John Bird
9. Chemistry in daily life by Kirpal Singh
10. Chemistry of bio molecules by S. P. Bhutan
11. Fundamentals of Computers by V. Raja Raman
12. Cyber Security Essentials by James Graham, Richard Howard, Ryan Olson



STUDENT ACTIVITIES

UNIT I: ESSENTIALS OF MATHEMATICS:

1: Complex Number Exploration

Provide students with a set of complex numbers in both rectangular and polar forms.

They will plot the complex numbers on the complex plane and identify their properties

2: Trigonometric Ratios Problem Solving

Give students a set of problems that require the calculation of trigonometric ratios and their relations.

Students will solve the problems using the appropriate trigonometric functions (sine, cosine, tangent, etc.) and trigonometric identities.

3: Vector Operations and Applications

Provide students with a set of vectors in Cartesian form.

Students will perform vector addition and subtraction operations to find the resultant vectors.

They will also calculate the scalar and vector products of given vectors.

4: Statistical Measures and Data Analysis

Give students a dataset containing numerical values.

Students will calculate the mean, median, and mode of the data, as well as other statistical measures if appropriate (e.g., range, standard deviation).

They will interpret the results and analyze the central tendencies and distribution of the data.

UNIT II: ESSENTIALS OF PHYSICS:

1. Concept Mapping

Divide students into groups and assign each group one of the topics.

Students will create a concept map illustrating the key concepts, relationships, and applications related to their assigned topic.

Encourage students to use visual elements, arrows, and labels to represent connections and interdependencies between concepts.

2. Laboratory Experiment

Select a laboratory experiment related to one of the topics, such as motion of objects or electric and magnetic fields.

Provide the necessary materials, instructions, and safety guidelines for conducting the experiment.

Students will work in small groups to carry out the experiment, collect data, and analyze the results.

After the experiment, students will write a lab report summarizing their findings, observations, and conclusions.



UNIT III: ESSENTIALS OF CHEMISTRY

1: Chemistry in Daily Life Presentation

Divide students into groups and assign each group a specific aspect of daily life where chemistry plays a significant role, such as food and nutrition, household products, medicine, or environmental issues.

Students will research and create a presentation (e.g., PowerPoint, poster, or video) that showcases the importance of chemistry in their assigned aspect.

2: Periodic Table Exploration

Provide students with a copy of the periodic table.

Students will explore the periodic table and its significance in organizing elements based on their properties.

They will identify and analyze trends in atomic structure, such as electronic configuration, atomic size, and ionization energy.

3: Chemical Changes and Classification of Matter

Provide students with various substances and chemical reactions, such as mixing acids and bases or observing a combustion reaction.

Students will observe and describe the chemical changes that occur, including changes in color, temperature, or the formation of new substances.

4: Biomolecules Investigation

Assign each student or group a specific biomolecule category, such as carbohydrates, proteins, fats, or vitamins.

Students will research and gather information about their assigned biomolecule category, including its structure, functions, sources, and importance in the human body.

They can create informative posters or presentations to present their findings to the class.

UNIT IV: APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

1: Interdisciplinary Case Studies

Divide students into small groups and provide them with interdisciplinary case studies that involve the interdisciplinary application of mathematics, physics, and chemistry.

Each case study should present a real-world problem or scenario that requires the integration of concepts from all three disciplines.

2: Design and Innovation Project

Challenge students to design and develop a practical solution or innovation that integrates mathematics, physics, and chemistry principles.

Students can choose a specific problem or area of interest, such as renewable energy, environmental conservation, or materials science.



3: Laboratory Experiments

Assign students laboratory experiments that demonstrate the practical applications of mathematics, physics, and chemistry.

Examples include investigating the relationship between concentration and reaction rate, analyzing the behavior of electrical circuits, or measuring the properties of materials.

.4: Mathematical Modeling

Present students with real-world problems that require mathematical modeling and analysis.

UNIT V: ESSENTIALS OF COMPUTER SCIENCE:

1. Identifying the attributes of network (Topology, service provider, IP address and bandwidth of
2. your college network) and prepare a report covering network architecture.
3. Identify the types of malwares and required firewalls to provide security.
4. Latest Fraud techniques used by hackers.



Course – I & II Model Paper Time:3Hrs (70 Marks)

SECTION A (Multiple Choice Questions)

$30 \times 1 = 30 M$

30 Multiple Choice Questions (Each Unit 6 Questions)

SECTION B (Fill in the blanks)

$10 \times 1 = 10 M$

10 Fill in the Blanks (Each Unit 2 Questions)

SECTION C (Very short answer questions)

$10 \times 1 = 10 M$

10 Very short answer questions (Each Unit 2 Questions)

SECTION D (Matching) (From 5 Units)

$2 \times 5 = 10 M$

1 A

B

C

D

E

2 A

B

C

D

E

SECTION E (True or False)

$10 \times 1 = 10 M$

10 True or False (Each Unit 2 Questions)



Single Major (w.e.f. AY 2023-24)

SEMESTER-I

COURSE – I ESSENTIALS AND APPLICATIONS OF MATHEMATICAL, PHYSICAL & CHEMICAL SCIENCES

Time:3hrs

MAX MARKS: 70 M

$3 \times 10 = 30 M$

I Multiple Choice Questions

1. If $\text{Arg}(\bar{Z}) < 0$ then $\text{Arg}(-Z) - \text{arg}(Z) =$ []
a) π b) $\frac{\pi}{4}$ c) $-\frac{\pi}{2}$ d) $\frac{\pi}{2}$

2. If $\left| \frac{Z_1}{Z_2} \right| = 1$ and $\text{Arg}(Z_1 Z_2) = 0$ then []
a) $Z_1 = Z_2$ b) $|Z_1|^2 = Z_1 Z_2$ c) $Z_1 Z_2 = 1$ d) None of these

3. The value of $\sin 50^\circ - \sin 70^\circ + \sin 10^\circ$ is equal to []
a) 1 b) 0 c) $\frac{1}{2}$ d) 2

4. If $\bar{a} + m\bar{b} + 3\bar{c}$, $-2\bar{a} + 3\bar{b} - 5\bar{c}$ and $\bar{a} - 3\bar{b} - 5\bar{c}$ are coplanar then $m =$ []
a) 2 b) -1 c) 1 d) $-9/7$

5. If the vectors $2\bar{i} + \lambda\bar{j} - \bar{k}$ and $4\bar{i} - 2\bar{j} + 2\bar{k}$ are perpendicular to each other, then []
 $\lambda =$ _____
a) 2 b) 5 c) 3 d) 1

6. Find the mode for the following data 0,0,1,1,2,2,2,4,5. []
a) 1 b) 0 c) 4 d) 2

7. Newton – Second is the unit of []
a) Velocity b) Angular Momentum c) Momentum d) Energy

8. If the force applied to a body is doubled and the mass is cut in half. What would be the acceleration ratio? []
a) 1:2 b) 2:1 c) 1:4 d) 4:1

9. Which unit is used to measure angle in the S.I system? []
a) Radian b) Steradian c) Degree d) Minute

10. The mass – Energy relation is given by []
a) $E = mc^2$ b) $F = ma$ c) $P = mv$ d) $W = Fd$

11. How many types of Robots are there []
a) 7 b) 10 c) 6 d) 8

12. Light energy emitted by stars is due to []
a) Breaking of nuclei b) Joining of nuclei
c) Burning of nuclei d) Reflection of Solar Light

13. Organic chemistry is the study of _____. []
a) Nitrogen based compounds b) Carbon based compounds
c) Copper based compounds d) Chromium based compounds

14. Number of electrons present in outer shell of chlorine atom is _____. []
a) 5 b) 6 c) 7 d) 8

15. Which of the following is a disaccharide _____. []
a) Sucrose b) Glucose c) Fructose d) Ribose

16. The Monomers present in proteins are _____. []
a) Alcohols b) Acids c) Amino acids d) Esters

17. Lipids composed mainly of _____. []
a) C, H, N b) C, H, O c) O, N, S d) N, S, Cl



18. Vitamin by is also known as _____ []
a) Vitamin – H b) Vitamin – O c) Vitamin – Bd) Vitamin – L

19. Who is introduced in Calculus _____. []
a) Isaac Newton b) Goff fried Leibniz
c) Both of the mentioned d) None of the mentioned

20. How many systems does a robot have _____. []
a) 2 b) 6 c) 4 d) 3

21. A place where power information (or) a result leaves a system. []
a) Chassis b) Output c) Sensor d) Input

22. The main electronic component used in first generation computers was []
a) Transistors b) Vacuum Tubes and Valves
c) Integrated Circuits d) None of above

23. Magnetic disk is an example of []
a) Secondary memory b) Primary memory
c) Main memory d) Both 1 & 2

24. http stands for []
a) hypertext transfer protocol b) hypertext transmission protocol
c) high transfer transport protocol d) hyper transfer text protocol

25. What is the full form of WWW? []
a) World Wide Web b) World with Web
c) Work Wide Web d) World Wide Wet

26. Which one of the following is a type of antivirus program? []
a) Quick heal b) Mcafee
c) Kaspersky d) All of the above

27. Hackers usually used the computer virus for _____ purpose. []
a) To log, monitor each and every user's stroke
b) To gain access the sensitive information like user's Id and Passwords
c) To corrupt the user's data stored in the computer system
d) All of the above

28. Which of the following is an example of fBDD screening technique []
a) U V spectroscopy b) HPLC c) NMR spectroscopy d) None

29. Fertilizers mainly consists of _____ []
a) N, P, K b) O, N, Cl c) C, O, K d) H, P, O

30. The substance that facilitate chemical reactions without being consumed is []
a) Reactions b) Product c) Catalyst d) Inhibin

SECTION – B

II Fill in the Blanks **10x1=10M**

1. Find the value of $\sqrt{3} \cosec 20^\circ - \sec 20^\circ$ is _____.

2. The area of the parallelogram whose diagonals are $3i + j - 2k$ and $i - 3j + 4k$ is _____.

3. _____ is the number of cycles made by a sounding body per unit time.

4. A light year is a unit of _____.

5. EXPAND SAR _____.

6. Peptide bond formula _____.

7. A robot is a _____.

8. Differential equations that _____ the definition of linear are nonlinear.

9. A string of 8 bits is _____.

10. ROM stands for _____.



SECTION – C

III Answer the following Short Questions 10x1=10M

1. If $3 \tan A = 5$ then Find Sin A and Cos A.
2. Find A.M from the following distribution.

Wages	100	120	140	160	180	200
No of workers	4	8	12	7	6	3

3. Write any two applications of Semi – Conductor?
4. Define Zeroth law of Thermodynamics? with example.
5. Expand FBDD.
6. What are fat soluble vitamins?
7. Define Newton's 1st Law.
8. Write any two application of Environmental monitoring?
9. What is E-mail?
10. What is a gateway?

SECTION – D

III Match the following 10x1=10M

1. A. Unit Vector in the direction $\vec{a} = 3\vec{i} - 2\vec{j} + 6\vec{k}$ () a) Angular Momentum
B. Polar form $-1 + \sqrt{3}i$ () b) Glucose
C. Joule x Sec () c) $\frac{1}{7} \left(3i - 2j + 6k \right) \left(\frac{2\pi}{3} \right) + i \sin \left(\frac{2\pi}{3} \right)$
D. Mass of a proton () d) $2 \cos \left(\frac{\pi}{3} \right) + i \sin \left(\frac{\pi}{3} \right)$
E. Reducing Sugar () e) 1.676×10^{-24} grams
2. A. Vitamin – B12 () a) Newton
B. Force () b) Newton second
C. Impulse () c) RBC formation
D. Punch Card () d) Computer games
E. Joy Stick () e) Hollerith code



SECTION – E

IV True (or) False

10x1=10M

1. If Z is a complex number then ZZ is purely real.
2. If Z is a complex number such that $Z^2 = (\bar{Z})^2$ then purely real.
3. The Mass of a body is equivalent to the ratio of the force action on it to the acceleration it generates.
4. The region of the atmosphere above troposphere is known as Lithosphere.
5. Essential Amino acids can be synthesized by the human body
6. Electrons fill the lowest energy levels first
7. For every action is nature here is an unequal and opposite reaction.
8. The special theory of relativity is concerned with frames of reference that are not experiencing any acceleration.
9. A terabyte is equal to 1 million gigabytes
10. Remote browser access is used to avoid browser-based hacking.



SEMESTER-I

COURSE 2: ADVANCES IN MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

Theory

Credits: 4

5 hrs/week

Course Objective:

The objective of this course is to provide students with an in-depth understanding of the recent advances and cutting-edge research in mathematical, physical, and chemical sciences. The course aims to broaden students' knowledge beyond the foundational concepts and expose them to the latest developments in these disciplines, fostering critical thinking, research skills, and the ability to contribute to scientific advancements.

Learning outcomes:

1. Explore the applications of mathematics in various fields of physics and chemistry, to understand how mathematical concepts are used to model and solve real-world problems.
2. To Explain the basic principles and concepts underlying a broad range of fundamental areas of physics and to Connect their knowledge of physics to everyday situations.
3. Understand the different sources of renewable energy and their generation processes and advances in nanomaterials and their properties, with a focus on quantum dots. To study the emerging field of quantum communication and its potential applications. To gain an understanding of the principles of biophysics in studying biological systems. Explore the properties and applications of shape memory materials.
4. Understand the principles and techniques used in computer-aided drug design and drug delivery systems, to understand the fabrication techniques and working principles of nanosensors. Explore the effects of chemical pollutants on ecosystems and human health.
5. Understand the interplay and connections between mathematics, physics, and chemistry in various advanced applications. Recognize how mathematical models and physical and chemical principles can be used to explain and predict phenomena in different contexts.
- 5 Understand and convert between different number systems, such as binary, octal, decimal, and hexadecimal. Differentiate between analog and digital signals and understand their characteristics. Gain knowledge of different types of transmission media, such as wired (e.g., copper cables, fiber optics) and wireless (e.g., radio waves, microwave, satellite).

UNIT I: ADVANCES IN BASICS MATHEMATICS

Straight Lines: Different forms – Reduction of general equation into various forms – Point of intersection of two straight lines

Limits and Differentiation: Standard limits – Derivative of a function – Problems on product rule and quotient rule

Integration: Integration as a reverse process of differentiation – Basic methods of integration



Matrices: Types of matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose of a matrix and determinants

UNIT II: ADVANCES IN PHYSICS:

Renewable energy: Generation, energy storage, and energy-efficient materials and devices.

Recent advances in the field of nanotechnology: Quantum dots, Quantum Communication- recent advances in biophysics- recent advances in medical physics- Shape Memory Materials.

UNIT III: ADVANCES IN CHEMISTRY:

Computer aided drug design and delivery, nano sensors, Chemical Biology, impact of chemical pollutants on ecosystems and human health, Dye removal - Catalysis method

UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

Mathematical Modelling applications in physics and chemistry

Application of Renewable energy: Grid Integration and Smart Grids,

Application of nanotechnology: Nanomedicine,

Application of biophysics: Biophysical Imaging, Biomechanics, Neurophysics,

Application of medical physics: Radiation Therapy, Nuclear medicine

Solid waste management, Environmental remediation- Green Technology, Water treatment.

UNIT V: Advanced Applications of computer Science

Number System-Binary, Octal, decimal, and Hexadecimal, Signals-Analog, Digital, Modem, Codec, Multiplexing, Transmission media, error detection and correction- Parity check and CRC, Networking devices- Repeater, hub, bridge, switch, router, gateway.

Recommended books:

1. Coordinate Geometry by S.L.Lony, Arihant Publications
2. Calculus by Thomas and Finny, Pearson Publications
3. Matrices by A.R.Vasishtha and A.K.Vasishtha, Krishna Prakashan Media(P)Ltd.
4. "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle
5. "Energy Storage: A Nontechnical Guide" by Richard Baxter
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and Raghvendra A. Bohara
7. "Biophysics: An Introduction" by Rodney Cotterill
8. "Medical Physics: Imaging" by James G. Webster
9. "Shape Memory Alloys: Properties and Applications" by Dimitris C. Lagoudas
10. Nano materials and applications by M.N.Borah
11. Environmental Chemistry by Anil.K.D.E.
12. Digital Logic Design by Morris Mano
13. Data Communication & Networking by Bahrouz Forouzan.



STUDENT ACTIVITIES

UNIT I: ADVANCES IN BASIC MATHEMATICS

1: Straight Lines Exploration

Provide students with a set of equations representing straight lines in different forms, such as slope-intercept form, point-slope form, or general form.

Students will explore the properties and characteristics of straight lines, including their slopes, intercepts, and point of intersection.

2: Limits and Differentiation Problem Solving

Students will apply the concept of limits to solve various problems using standard limits.

Encourage students to interpret the results and make connections to real-world applications, such as analyzing rates of change or optimizing functions.

3: Integration Exploration

Students will explore the concept of integration as a reverse process of differentiation and apply basic methods of integration, such as the product rule, substitution method, or integration by parts.

Students can discuss the significance of integration in various fields, such as physics and chemistry

4: Matrices Manipulation

Students will perform operations on matrices, including scalar multiplication, matrix multiplication, and matrix transpose.

Students can apply their knowledge of matrices to real-world applications, such as solving systems of equations or representing transformations in geometry.

UNIT II: ADVANCES IN PHYSICS:

1: Case Studies

Provide students with real-world case studies related to renewable energy, nanotechnology, biophysics, medical physics, or shape memory materials.

Students will analyze the case studies, identify the challenges or problems presented, and propose innovative solutions based on the recent advances in the respective field. They will consider factors such as energy generation, energy storage, efficiency, sustainability, materials design, biomedical applications, or technological advancements.

2: Experimental Design

Assign students to design and conduct experiments related to one of the topics: renewable energy, nanotechnology, biophysics, medical physics, or shape memory materials.

They will identify a specific research question or problem to investigate and design an experiment accordingly.

Students will collect and analyze data, interpret the results, and draw conclusions based on their findings.

They will discuss the implications of their experimental results in the context of recent advances in the field.

3: Group Discussion and Debate

Organize a group discussion or debate session where students will discuss the ethical, social, and



environmental implications of the recent advances in renewable energy, nanotechnology, biophysics, medical physics, and shape memory materials.

Assign students specific roles, such as proponent, opponent, or moderator, and provide them with key points and arguments to support their positions.

UNIT III: ADVANCES IN CHEMISTRY:

1. Experimental Design and Simulation

In small groups, students will design experiments or simulations related to the assigned topic.

For example, in the context of computer-aided drug design, students could design a virtual screening experiment to identify potential drug candidates for a specific disease target.

For nano sensors, students could design an experiment to demonstrate the sensitivity and selectivity of nano sensors in detecting specific analytes.

Chemical biology-related activities could involve designing experiments to study enzyme-substrate interactions or molecular interactions in biological systems.

Students will perform their experiments or simulations, collect data, analyze the results, and draw conclusions based on their findings.

2. Case Studies and Discussion

Provide students with real-world case studies related to the impact of chemical pollutants on ecosystems and human health.

Students will analyze the case studies, identify the sources and effects of chemical pollutants, and propose mitigation strategies to minimize their impact.

Encourage discussions on the ethical and environmental considerations when dealing with chemical pollutants.

For the dye removal using the catalysis method, students can explore case studies where catalytic processes are used to degrade or remove dyes from wastewater.

Students will discuss the principles of catalysis, the advantages and limitations of the catalysis method, and its applications in environmental remediation.

3: Group Project

Assign students to work in groups to develop a project related to one of the topics.

The project could involve designing a computer-aided drug delivery system, developing a nano sensor for a specific application, or proposing strategies to mitigate the impact of chemical pollutants on ecosystems.

Students will develop a detailed project plan, conduct experiments or simulations, analyze data, and present their findings and recommendations.

Encourage creativity, critical thinking, and collaboration throughout the project.



UNIT IV: ADVANCED APPLICATIONS OF MATHEMATICS, PHYSICS & CHEMISTRY

1: Mathematical Modelling Experiment

Provide students with a mathematical modelling experiment related to one of the topics. For example, in the context of renewable energy, students can develop a mathematical model to optimize the placement and configuration of solar panels in a solar farm.

Students will work in teams to design and conduct the experiment, collect data, and analyze the results using mathematical models and statistical techniques.

They will discuss the accuracy and limitations of their model, propose improvements, and interpret the implications of their findings in the context of renewable energy or the specific application area.

2: Case Studies and Group Discussions

Assign students to analyze case studies related to the applications of mathematical modelling in nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

Students will discuss the mathematical models and computational methods used in the case studies, analyze the outcomes, and evaluate the effectiveness of the modelling approach.

Encourage group discussions on the challenges, ethical considerations, and potential advancements in the field.

Students will present their findings and engage in critical discussions on the advantages and limitations of mathematical modelling in solving complex problems in these areas.

3. Group Project

Assign students to work in groups to develop a group project that integrates mathematical modelling with one of the application areas: renewable energy, nanotechnology, biophysics, medical physics, solid waste management, environmental remediation, or water treatment.

The project could involve developing a mathematical model to optimize the delivery of radiation therapy in medical physics or designing a mathematical model to optimize waste management practices.

Students will plan and execute their project, apply mathematical modelling techniques, analyze the results, and present their findings and recommendations. Encourage creativity, critical thinking, and collaboration throughout the project.

UNIT V: Advanced Applications of computer Science

Students must be able to convert numbers from other number system to binary number systems

1. Identify the networking media used for your college network
2. Identify all the networking devices used in your college premises.



Course – I & II Model Paper Time: 3Hrs (70 Marks)

SECTION A (Multiple Choice Questions) $30 \times 1 = 30 M$

30 Multiple Choice Questions (Each Unit 6 Questions)

SECTION B (Fill in the blanks) $10 \times 1 = 10 M$

10 Fill in the Blanks (Each Unit 2 Questions)

SECTION C (Very short answer questions) **$10 \times 1 = 10 \text{ M}$**

10 Very short answer questions (Each Unit 2 Questions)

$$2 \times 5 = 10 M$$

1 A

B

C

D

E

2 A

B

C

6

E

SECTION E (True or False) ***10 x 1 = 10 M***

10 True or False (Each Unit 2 Questions)



Single Major (w.e.f. AY 2023-24)
SEMESTER-I
Model Paper

COURSE -2 ADVANCES OF MATHEMATICAL, PHYSICAL & CHEMICAL SCIENCES
Time: 3Hrs **MAX MARKS: 70 M**

I Multiple Choice Questions 3x10=30M

SECTION – A

1. The equation of the line passing through the point $(1, 2)$ and perpendicular to the line $x+y+1=0$ is []
 a) $y-x+1=0$ b) $y-x-1=0$ c) $y-x+2=0$ d) $y-x-2=0$

2. $\lim_{x \rightarrow 0} \frac{y-x+1}{x^2}$ is equal to []
 a) 0 b) 1 c) 2 d) 4

3. The derivative of $\cos^{-1}(2x^2 - 1)$ w.r.to $\cos^{-1}(x)$ is []
 a) 2 b) $\frac{-1}{2\sqrt{1-x^2}}$ c) $\frac{2}{x}$ d) $1-x^2$

4. $\int e^{\tan x} \sec^2 x \, dx =$ []

5. If $2x + y = \begin{bmatrix} 1 \\ -3 \end{bmatrix}$ and $2x - y = \begin{bmatrix} 3 \\ -1 \end{bmatrix}$ then X is equal to []
 a) $\begin{bmatrix} 4 \\ -4 \end{bmatrix}$ b) $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$ c) $\begin{bmatrix} -1 \\ -1 \end{bmatrix}$ d) None of these

6. If $A = [a_{ij}]_{m \times n}$ such that $a_{ij} = 0$ for $i \neq j$ then A is []
 a) a row matrix b) a column matrix
 c) a diagonal matrix d) a scalar matrix

7. Which of the following is an renewable energy source []
 a) Coal b) Natural gas c) Solar d) Nuclear

8. What is the main purpose of Photovoltaic cells in solar panels []
 a) Heat generation b) Electricity generation c) Water purification d) Carbon capture

9. Which renewable energy source is harnessed from the earth's Internal heat? []
 a) Solar b) Wind c) Geothermal d) Hydro

10. What is the fundamental principle behind quantum mechanics []
 a) Classical Mechanics b) Quantum Superposition c) Newton law of motion d) Maxwell's equation

11. What is the primary application of proton therapy in medical physics? []
 a) Diagnostic Imaging b) Radiation therapy c) Magnetic resonance Imaging
 d) Computed Tomography (C.T)

12. What is the primary advantage of using quantum dob in solar cells? []
 a) Low cost b) High efficiency
 c) Fast charging d) Large size

13. The Binding capacity between the drug and target is known as []
 a) Virtual Screening b) Docking Score c) ADMET d) None

14. The Increased sensitivity of Nanosensors is due to []
 a) High Surface-to-volume ratio b) Low surface-to-volume ratio

15. The green pigment chlorophyll is affected by []
 a) CO_2 b) NO_2 c) SO_2 d) CH_4



16. What is the Photo catalyst used in the dye removal catalysis method []
a) Oxygen b) Hydrogen c) Titanium Oxide d) Zinc

17. Which phase of Shape memory alloy occurs at higher temperature & has a needle – like structure []
a) Martensite b) Austenite c) Hysterisis d) None

18. The Pollutant causing Global warming []
a) CO_2 b) SO_2 c) NO_2 d) O_3

19. In Quantum mechanics, the Schrodinger Equation is a fundamental Equation, used to model the behavior of particles. What does the Schrodinger Equation describe []
a) Stability b) Wave-Particle duality
c) Degidity d) Massive

20. What is the term used to describe the process of using nano particles to enhance imaging techniques for medical diagnostics []
a) Nano Scopy b) Nano Therapy c) Nano Diagnose d) None of these

21. How can nano medicine contribute to personalized medicine? []
a) By increasing the cost of medical treatment.
b) By using a one-size –fits all approach.
c) By tailoring based on an individual's genetic make-up.
d) By avoiding the use of advanced technologies.

22. In radiation therapy, What does the term “brachytherapy” refer to []
a) External beam radiation therapy
b) Radiation therapy using photons
c) Internal radiation therapy involving the placement of radio active sources directly within or close to the tumor.
d) Radiation therapy without the use of imaging.

23. What is the purpose of coagulation in the water treatment process? []
a) Removing dissolved minerals
b) Disinfecting water
c) Settling suspended particulates
d) Adjusting PH levels

24. What is the purpose of green building design and construction? []
a) maximizing energy consumption
b) minimizing the use of sustainable materials
c) Reducing the environmental impact of buildings
d) Ignoring energy – efficient technologies

25. Hybrid system combine which two types of signals? []
a) Analog and Analog b) Digital and Digital c) Analog and Digital d) Continuous and Finite

26. Which error detection technique can detect a wide range of errors including burst errors and most multiple bits. []
a) Hamming code b) Read- Solomon code c) Parity check d) CRC

27. Which layer of the OSI model does a router operate at []
a) Transport layer b) Network layer c) Transport layer d) Data link layer

28. What technology allows DSL modems to separate voice and data signals. []
a) Dial-up modem b) DSL modem c) Wireless modem d) Cable modem

Ans b) DSL modem

29. What protocol do bridges use to prevent network loops? []
a) Internet Protocol b) Transmission Control Protocol (TCP)
c) Simple Network Management Protocol (SNMP) d) Spanning Tree Protocol (STP)

30. The..... between two words is the number of difference between corresponding bits []
a) Hamming code b) Hamming distance
c) Hamming rule d) Hamming data



SECTION – B

III Fill in the Blanks

10x1=10M

1. Tidal energy is an Example for _____ energy.
2. _____ are the particles used in quantum dots.
3. Expand CADD _____
4. First step in the purification of water _____
5. _____ is an application for Medical Physics.
6. MRI stands for _____
7. $\int e^x \sin x \cos x dx =$ _____.
8. Equation of the lines through the point (3, 2) and making an angle of 45° with the line $x-2y=3$ are _____.
9. A computer understands only code
10. converts audio and video into digital information

SECTION – C

III Answer the following Questions

10x1=10M

1. Give some Examples for renewable sources?
2. Information stored in quantum computer in the form of?
3. What is the difference between MRI and C.T. Scan?
4. Name two applications of Nanotechnology?
5. Solid waste Management? (SWM)
6. Expand ADMET
7. $x \rightarrow 0 \frac{ax + x \cos x}{b \sin x}$; Evaluate
8. Evaluate $\int x(\log x)^2 dx$
9. What are the key design issues of the computer networks?
10. What is multiplexing?

SECTION – D

III Match the following

10x1=10M

1. A. Wind energy	() a) Orthodontic applications
B. Solar energy	() b) Non invasile imaging
C. Minamata	() c) Harness the kinetic energy of wind to produce electricity
D. Ni-Ti wire	() d) Convert sunlight into electricity
E. Magnetic Resonance Imaging	() e) Mercury
2. A. Fluorescene microscopy	() a) 3
B. $\begin{bmatrix} 3 & -4 \\ m & 5 \end{bmatrix} = 3$ then m value is	() b) Moniterity cellular
C. $\frac{d}{dx} [\log(\sec x + \tan x)]$	() c) F1
D. 11110001	() d) Guided media
E. Ethernet cable	() e) $(\sec x)$



SECTION – E

IV True (or) False

10x1=10M

1. Quantum dots are the nano particles, are primarily used for structural Reintor cement in medical implants?
2. Quantum mechanics is a branch of physics Extensively used mathematical Models, to describe the behavior of particles at atomic and subatomic level.
3. The Mass of a body is equivalent to the ratio of the force action on it to the acceleration it generates.
4. The region of the atmosphere above troposphere is known as Lithosphere.
5. Essential Amino acids can be synthesized by the human body
6. Electrons fill the lowest energy levels first
7. The equation of a line with slope m and making an intercept c on y axis is $y=mx+c$
8. Intercept form of a line which cuts a and b respectively on the x and y axis
Then
$$\frac{x}{a} + \frac{y}{b} = 1$$
9. A university would use a CAN to converts its composes in two cities.
10. Gateway device is operate at transport layer.



SEMESTER-II
COURSE 3: 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 behaviour 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 understand and apply the concepts of scalar and vector fields, calculate the gradient of a scalar field, determine the divergence and curl of a vector field.
2. Students will be able to apply the laws of motion, solve equations of motion for variable mass systems
3. Students will be able to define a rigid body and comprehend rotational kinematic relations, derive equations of motion for rotating bodies, analyze the precession of a top and gyroscope, understand the precession of the equinoxes
4. Students will be able to define central forces and provide examples, understand the characteristics and conservative nature of central forces, derive equations of motion under central forces.
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 VECTOR ANALYSIS

Scalar and vector fields, gradient of a scalar field and its physical significance. Divergence and curl of a vector field with derivations and physical interpretation. Vector integration (line, surface and volume), Statement and proof of Gauss and Stokes theorems.

UNIT-II MECHANICS OF PARTICLES

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-III MECHANICS OF RIGID BODIES AND CONTINUOUS MEDIA

Definition of rigid body, rotational kinematic relations, equation of motion for a rotating body, Precession of a top, Gyroscope, Precession of the equinoxes. Elastic constants of isotropic solids and their relations, Poisson's ratio and expression for Poisson's ratio. Classification of beams, types of bending, point load, distributed load.



UNIT-IV CENTRAL FORCES

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 . Derivation of Kepler's laws. Motion of satellites

UNIT-V SPECIAL THEORY OF RELATIVITY

Galilean relativity, Absolute frames. Michelson-Morley experiment, The 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 & Subrmanyam, S. Chand &Co. 1982
7. Dynamics of Particles and Rigid bodies– Anil Rao, Cambridge Univ Press, 2006
8. Mechanics-EM Purcell, Mc Graw Hill
9. University Physics-FW Sears, MW Zemansky & HD Young, Narosa Publications, Delhi
10. College Physics-I. T. Bhima sankaram and G. Prasad. Himalaya Publishing House.
11. Mechanics, S. G. Venkata chalapathy, Margham Publication, 2003.



SEMESTER-II
COURSE 3: MECHANICS AND PROPERTIES OF MATTER

Practical	Credits: 1	2hrs/week
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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. Viscosity of liquid by the flow method (Poiseuille's method)
2. Young's modulus of the material of a bar (scale) by uniform bending
3. Young's modulus of the material a bar (scale) by non- uniform bending
4. Surface tension of a liquid by capillary rise method
5. Determination of radius of capillary tube by Hg thread method
6. Viscosity of liquid by Searle's viscometer method
7. Bifilar suspension –moment of inertia of a regular rectangular body.
8. Determination of moment of inertia using Fly-wheel
9. Determination of the height of a building using a sextant.
10. Rigidity modulus of material of a wire-dynamic method (torsional pendulum)



STUDENT ACTIVITIES

Unit I: Vector Analysis

Activity: Field Mapping

Students can choose a physical field (e.g., temperature, magnetic field) and create a field map by taking measurements at different points. They can then calculate the gradient of the field and analyse the variations. This activity helps them understand the concept of gradient in a scalar field.

Unit II: Mechanics of Particles

Activity: Collision Experiments

Students can set up simple collision experiments using marbles, carts, or other objects. They can measure the initial and final velocities, masses, and analyze the momentum conservation. By varying the conditions (e.g., masses, initial velocities), they can observe the effects on the collision outcomes.

Unit III: Mechanics of Rigid Bodies and Continuous Media

Activity: Balancing Act

Students can experiment with balancing various objects (e.g., rulers, books) on different points to understand the concept of center of mass and stability. They can analyse the equilibrium conditions and explore how the position of the center of mass affects the stability.

Unit IV: Central Forces

Activity: Pendulum Motion

Students can investigate the motion of a simple pendulum by varying its length and measuring the time period. They can analyze the relationship between the period and the length, and discuss the concept of centripetal force and its role in circular motion.

Unit V: Special Theory of Relativity

Activity: Time Measurement

Students can perform a time measurement experiment using simple devices like water clocks or sand timers. They can compare the measured time between two events at different relative speeds and discuss the concept of time dilation



SEMESTER-II
COURSE 4: WAVES AND OSCILLATIONS

Theory

Credits: 3

3hrs/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 quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments.

LEARNING OUTCOMES:

The student should be able

1. To describe the basic characteristics of waves such as frequency, wavelength, amplitude, period, and speed.
2. To utilize mathematical relationships related to wave characteristics.
3. To compare particle motion and wave motion in different types of waves.
4. To distinguish between Longitudinal and Transverse waves.
5. To get the knowledge about how to construct and analysis the square waves, saw tooth waves, etc. from Fourier analysis

UNIT-I Simple Harmonic oscillations

Simple harmonic oscillator and solution of the differential equation-Physical characteristics of SHM, torsion pendulum-measurements of rigidity modulus, compound pendulum- measurement of 'g', Principle of superposition, beats, combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies. Lissajous figures.

UNIT-II Damped and forced oscillations

Damped harmonic oscillator, solution of the differential equation of damped oscillator. Energy considerations, comparison with un-damped harmonic oscillator, logarithmic decrement, relaxation time, quality factor, differential equation of forced oscillator and its solution, amplitude resonance and velocity resonance.

UNIT-III Complex vibrations

9hr

Fourier theorem and evaluation of the Fourier coefficients, analysis of periodic wave functions-square wave, triangular wave, saw tooth wave, simple problems on evolution of Fourier coefficients.



UNIT-IV Vibrating Strings and Bars

Transverse wave propagation along a stretched string, general solution of wave equation and its significance, modes of vibration of stretched string clamped at ends, overtones and harmonics. Energy transport and transverse impedance. Longitudinal vibrations in bars-wave equation and its general solution. Special cases (i) bar fixed at both ends (ii) bar fixed at the midpoint (iii) bar fixed at one end. Tuning fork.

UNIT-V Ultrasonics:

Ultrasonics, properties of ultrasonic waves, production of ultrasonics by piezoelectric and magnetostrictive methods, detection of ultrasonics, determination of wavelength of ultrasonic waves. Applications and uses of ultrasonic waves.

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. College Physics-I. T. Bhimasankaram and G. Prasad. Himalaya Publishing House.
5. Science and Technology of Ultrasonics- Baldevrajk, Narosa, New Delhi,2004
6. Introduction to Physics for Scientists and Engineers. F.J. Buche. McGraw Hill.



SEMESTER-II
COURSE 4: WAVES AND OSCILLATIONS

Practical

Credits: 1

2hrs/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 quantitative reasoning skills, to empower them to think creatively and critically about scientific problems and experiments.

LEARNING OUTCOMES:

1. Students are made to determine the unknown frequency of tuning fork by volume resonator experiment
2. Students are made to determine 'g' by compound/bar pendulum
3. Students are made to determine the force constant of a spring by static and dynamic method.
4. Students are made to determine the elastic constants of the material of a flat spiral spring.
5. Students are made to verify the laws of vibrations of stretched string –sonometer
6. Students are made to determine the frequency of a bar –Melde's experiment.
7. Students are made to study the damped oscillation using the torsional pendulum immersed in liquid-decay constant and damping correction of the amplitude.
8. Students are made to form Lissajous figures using CRO.

Minimum of 6 experiments to be done and recorded

Experiments

1. Volume resonator experiment
2. Determination of 'g' by compound/bar pendulum
3. Simple pendulum normal distribution of errors-estimation of time period and the error of the mean by statistical analysis
4. Determination of the force constant of a spring by static and dynamic method.
5. Determination of the elastic constants of the material of a flat spiral spring.
6. Coupled oscillators
7. Verification of laws of vibrations of stretched string –sonometer
8. Determination of frequency of a bar –Melde's experiment.
9. Study of a damped oscillation using the torsional pendulum immersed in liquid-decay constant and damping correction of the amplitude.
10. Formation of Lissajous figures using CRO.



STUDENT ACTIVITIES

Unit-I Simple Harmonic oscillations:

Activity: Measuring the period of a simple pendulum and verifying the relationship between the period and the length of the pendulum. Students can use a stopwatch and a ruler to measure the time for a fixed number of oscillations and calculate the period.

Unit-II Damped and forced oscillations:

Activity: Measuring the damping coefficient of a mass-spring system and calculating the quality factor. Students can measure the amplitude of the system as it undergoes damped oscillations and use the logarithmic decrement formula to calculate the damping coefficient. They can then use the formula for the quality factor to evaluate the quality of the system.

Unit-III Complex vibrations:

Activity: Constructing a square wave using Fourier series and analyzing its Fourier coefficients. Students can use a software tool or a programming language to generate a square wave and then compute the Fourier coefficients. They can then plot the magnitude spectrum of the waveform and observe the harmonic components.

Unit-IV Vibrating Strings and Bars:

Activity: Measuring the speed of sound in a metal rod and comparing it with the theoretical value. Students can use a microphone and an oscilloscope to measure the time delay between two reflections of a sound pulse in the rod. They can then use the formula for the speed of sound in a solid to calculate the speed and compare it with the theoretical value.

Unit-V Ultrasonics:

Activity: Measuring the wavelength of ultrasonic waves using the diffraction of light. Students can use a laser and a diffraction grating to create a diffraction pattern of an ultrasonic wave. They can then measure the distance between the diffraction fringes and use the formula for the diffraction of light to calculate the wavelength of the ultrasonic wave.



**Single Major
Model Question Paper
SEMESTER-II
Physics**

Paper: 3- Mechanics and Properties of Matter

Time:3hrs

MAX MARKS: 70 M

SECTION – A

Answer any Five questions. Each question carries 4 marks **5 X 4 = 20 M**

1. Define the gradient of scalar field. Write its physical significance.
2. Explain the conservation of energy and momentum.
3. Write a short note on classification of beams.
4. Write the characteristics of central forces.
5. Derive Einstein's mass-energy relation.
6. Find the divergence of \mathbf{A} at point $(1, -1, 1)$ when $\mathbf{A} = x^2z \mathbf{i} - 2y^3z^2 \mathbf{j} + xy^2z \mathbf{k}$.
7. Describe the working of Gyroscope.
8. If the earth be one-half of its present distance from the Sun, what will be the number of days in a year?

SECTION – B

Answer All the questions. Each question carries 10 marks **5 X 10 = 50 M**

9. (A) Define curl of a vector and derive its expression. Give the physical significance of curl.

(OR)

- (B) State and prove Gauss's divergence theorem.

10. (A) Derive an expression for the velocity of a rocket at any given time.

(OR)

- (B) Derive an expression for Rutherford's scattering angle.

11. (A) Obtain an expression for precessional velocity of a symmetric top.

(OR)

- (B) Derive relation between y , n , k and σ .

12. (A) Define central force. Give two examples. Show that central forces are conservative.

(OR)

- (B) State and prove Kepler's first law.

13. (A) Describe Michelson-Morley experiment with necessary theory? Explain the negative result.

(OR)

- (B) Write the postulates of special theory of relativity? Derive Lorentz transformation equations.



**Single Major
Model Question Paper
SEMESTER-II
Physics
Paper: 4- Waves & Oscillations**

Time:3hrs

MAX MARKS: 70 M

SECTION – A

Answer any Five questions. Each question carries 4 marks **5 X 4 = 20 M**

1. What are Lissajous figures? Write any two applications of Lissajous figures?
2. Write a short note on velocity resonance.
3. List the applications and the limitations of Fourier theorem?
4. State and explain Fourier theorem.
5. Write a short note on tuning fork.
6. What are overtones and harmonics?
7. Write the applications of Ultrasonic waves.
8. Write any 5 characteristics of SHM.

SECTION – B

Answer All the questions. Each question carries 10 marks **5 X 10 = 50 M**

9. (A) Define compound pendulum. Explain how you determine acceleration due to gravity using compound pendulum.
(OR)
(B) Explain the combination of two mutually perpendicular simple harmonic vibrations with 2:1 frequency?
10. (A) What are damped harmonic oscillations? Derive the equation of motion of damped harmonic oscillator and find its general solution?
(OR)
(B) What are forced oscillations? Discuss the differential equation of a forced damped oscillator and obtain its general solution?
11. (A) State and explain Fourier theorem? Derive the expressions for Fourier coefficients?
(OR)
(B) State Fourier theorem? Analyse a square wave using Fourier theorem?
12. (A) Derive the expression for the velocity of transverse wave along a stretched string. State the laws of transverse vibrations in strings?
(OR)
(B) Discuss the modes of vibrations of stretched string clamped at ends.
13. (A) What are ultrasonic waves? Describe how ultrasonic waves are produced by the method of Piezo electric method.
(OR)
(B) What are ultrasonic waves? Describe how ultrasonic waves are produced by the method of magnetostriction method.



SEMESTER-III
COURSE 5: OPTICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Optics aims to provide students with a fundamental understanding of the behaviour and properties of light and its interaction with matter.

LEARNING OUTCOMES:

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

1. Explain about the different aberrations in lenses and discuss the methods of minimizing them
2. Understand the phenomenon of interference of light and its formation in (i) Lloyd's single mirror due to division of wave front and (ii) Thin films, Newton's rings and Michelson interferometer due to division of amplitude.
3. Distinguish between Fresnel's diffraction and Fraunhoffer diffraction and observe the diffraction patterns in the case of single slit and the diffraction grating and to describe the construction and working of zone plate and make the comparison of zone plate with convex lens
4. Explain the various methods of production of plane, circularly and polarized light and their detection and the concept of optical activity.
5. Comprehend the basic principle of laser, the working of He-Ne laser and Ruby lasers and their applications in different fields. To understand the basic principles of fibre optic communication and explore the field of Holography and Nonlinear optics and their applications.

UNIT-I Aberrations

Introduction – 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-II 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) –colors of thin films- Interference by a film with two non-parallel reflecting surfaces (Wedge shaped film). Determination of diameter of wire, Newton's rings in reflected light. Determination of wavelength of monochromatic light using Newton's rings and Michelson Interferometer.

UNIT-III Diffraction

Introduction, distinction between Fresnel and Fraunhoffer diffraction, Fraunhoffer diffraction – Diffraction due to single slit-Fraunhoffer, Fraunhofer diffraction pattern with N slits (diffraction grating). Resolving power of grating, Determination of wavelength of light in normal incidence using diffraction grating. Fresnel's half period zones-area of the half period zones-zone plate-comparison of zone plate with convex lens-difference between interference and diffraction.



UNIT-IV Polarisation

Polarized light: methods of polarization by reflection, refraction, double refraction, Brewster's law- Mau's 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-V Lasers and Holography

Lasers: introduction, spontaneous emission, stimulated emission. Population Inversion, Laser principle- Einstein Coefficients-Types of lasers-He-Ne laser, Ruby laser- Applications of lasers. Holography: Basic principle of holography-Gabor hologram and its limitations, Applications of holography.

REFERENCE BOOKS:

1. BSc Physics, Vol .2, Telugu Academy, Hyderabad
2. A Text Book of Optics-N Subramanyam, L Brijlal, S. Chand & Co.
3. Unified Physics Vol. II Optics & Thermodynamics – Jai Prakash Nath & Co. Ltd., Meerut
4. Optics, F.A. Jenkins and H.G. White, Mc Graw-Hill
5. Optics, Ajay Ghatak, Tata Mc Graw-Hill.
6. Introduction of Lasers – Avadhanulu, S. Chand & Co.
7. Principles of Optics- BK Mathur, Gopala Printing Press, 1995



SEMESTER-III
COURSE 5: OPTICS

Credits: 1

Practical

2hrs/week

COURSE OBJECTIVE:

To develop practical skills in the use of laboratory equipment and experimental techniques for studying light and its interactions with matter.

LEARNING OUTCOMES:

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques for studying light and its interactions with matter.
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 optics, including reflection, refraction, diffraction, interference, and polarization.

Minimum of 6 experiments to be done and recorded

1. Determination of radius of curvature of a given convex lens-Newton's rings.
2. Resolving power of grating.
3. Study of optical rotation –polarimeter.
4. Dispersive power of a prism.
5. Determination of wavelength of light using diffraction grating-minimum deviation method.
6. Determination of wavelength of light using diffraction grating-normal incidence method.
7. Determination of wavelength of laser light using diffraction grating.
8. Resolving power of a telescope.
9. Refractive index of a liquid-hallow prism
10. Determination of thickness of a thin wire by wedge method
11. Determination of refractive index of liquid-Boy's method.



STUDENT ACTIVITIES

Suggested student activities

UNIT-I Aberrations:

Ask students to observe and sketch the different images produced by the lens at different distances. Build a simple optical system with two lenses in contact and ask students to calculate the focal length and magnification of the system. Then, introduce a thin glass plate between the lenses to simulate the effects of chromatic aberration and ask students to observe and discuss the changes in the image produced.

UNIT-II Interference:

Ask students to measure the diameter of the central bright spot and the diameter of the n th ring for different values of n , and then calculate the wavelength of light.

UNIT-III Diffraction:

Build a simple diffraction grating using a piece of cardboard and some sewing needles. Ask students to measure the distance between the needles, count the number of lines per unit length, and then calculate the grating spacing and the wavelength of light.

UNIT-IV Polarisation:

Ask students to measure the angle of rotation of the polarized light before and after passing through the sample, and then calculate the specific rotation of the sample.

UNIT-V Lasers and Holography:

Demonstrate the principle of holography using a laser beam, a beam splitter, and a photographic plate. Ask students to record a hologram of a simple object and then reconstruct the image using a laser beam.



SEMESTER-III
COURSE 6: HEAT AND THERMODYNAMICS

Theory	Credits: 3	3 hrs/week
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COURSE OBJECTIVE:

The course on Heat and Thermodynamics aims to provide students with a fundamental understanding of the principles of heat and energy transfer and their applications in various fields

LEARNING OUTCOMES:

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

1. Understand the basic aspects of kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions and the transport phenomenon in ideal gases
2. Gain knowledge on the basic concepts of thermodynamics, the first and the second law of thermodynamics, the basic principles of refrigeration, the concept of entropy, the thermodynamic potentials and their physical interpretations. Understand the working of Carnot's ideal heat engine, Carnot cycle and its efficiency
3. Develop critical understanding of concept of Thermodynamic potentials, the formulation of Maxwell's equations and its applications.
4. Differentiate between principles and methods to produce low temperature, liquefy air, and understand the practical applications of substances at low temperatures.
5. Examine the nature of black body radiations and the basic theories

UNIT-I: KINETIC THEORY OF GASES:

Kinetic Theory of gases- Introduction, Maxwell's law of distribution of molecular velocities, Mean free path, Principle of equipartition of energy, Transport phenomenon in ideal gases: viscosity and Thermal conductivity.

UNIT-II: THERMODYNAMICS:

Introduction- Reversible and irreversible processes, Carnot's engine and its efficiency, Carnot's theorem, Thermodynamic scale of temperature, Second law of thermodynamics Entropy: Physical significance, Change in entropy in reversible and irreversible processes; Temperature-Entropy (T-S) diagram and its uses; change of entropy when ice changes into steam.

UNIT-III: THERMODYNAMIC POTENTIALS AND MAXWELL'S EQUATIONS:

Thermodynamic Potentials-Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy and their significance, Derivation of Maxwell's thermodynamic relations from thermodynamic potentials, Applications to (i) Clausius-Clayperon's equation (ii) Joule-Kelvin coefficient for ideal and Van der Waals' gases.



UNIT-IV: LOW TEMPERATURE PHYSICS:

Methods for producing very low temperatures, Joule Kelvin effect, porous plug experiment, Joule expansion, Distinction between adiabatic and Joule Thomson expansion, Expression for Joule Thomson cooling, Production of low temperatures by adiabatic demagnetization (qualitative).

UNIT-V: QUANTUM THEORY OF RADIATION:

Spectral energy distribution of black body radiation, Wein's displacement law and Rayleigh-Jean's law (No derivations), Planck's law of black body radiation-Derivation, Deduction of Wein's law and Rayleigh- Jean's law from Planck's law, Solar constant and its determination using Angstrom pyro heliometer, Estimation of surface temperature of Sun.

REFERENCE BOOKS

1. BSc Physics, Vol.2, Telugu Akademy, Hyderabad
2. Thermodynamics, R.C.Srivastava, S.K.Saha & Abhay K.Jain, Eastern Economy Edition.
3. Unified Physics Vol.2, Optics & Thermodynamics, Jai Prakash Nath & Co. Ltd., Meerut
4. Fundamentals of Physics. Halliday/Resnick/Walker. C. Wiley India Edition 2007
5. Heat and Thermodynamics -N BrijLal, P Subrahmanyam, S.Chand& Co.,2012
6. Heat and Thermodynamics- MS Yadav, Anmol Publications Pvt. Ltd, 2000
7. University Physics, HD Young, MW Zemansky, FW Sears, Narosa Publishers, New Delhi



SEMESTER-III
COURSE 6: HEAT AND THERMODYNAMICS

Practical	Credits: 1	2 hrs/week
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COURSE OBJECTIVE:

The objectives for practicals in Heat and Thermodynamics can vary depending on the specific course or program, but here are some general objectives that may apply, to develop practical skills in the use of laboratory equipment and experimental techniques for studying heat and thermodynamics.

LEARNING OUTCOMES:

1. Mastery of experimental techniques: Students should become proficient in using laboratory equipment and experimental techniques for studying heat and thermodynamics.
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 heat and thermodynamics, including the laws of thermodynamics, heat transfer, and thermodynamic cycles.

Minimum of 6 experiments to be done and recorded

1. Specific heat of a liquid –Joule’s calorimeter –Barton’s radiation correction
2. Thermal conductivity of bad conductor-Lee’s method
3. Thermal conductivity of rubber.
4. Measurement of Stefan’s constant.
5. Specific heat of a liquid by applying Newton’s law of cooling correction.
6. Heating efficiency of electrical kettle with varying voltages.
7. Thermo emf- thermo couple - Potentiometer
8. Thermal behavior of an electric bulb (filament/torch light bulb)
9. Measurement of Stefan’s constant- emissive method
10. Study of variation of resistance with temperature - Thermistor.



STUDENT ACTIVITIES

UNIT I: Kinetic Theory of Gases

Activity: Speed Distribution Analysis

Students can conduct a simple experiment using gas molecules (e.g., small balls) in a container. They can measure the speeds of the molecules using a motion sensor or stopwatch and analyze the distribution of molecular velocities. They can compare the observed distribution with the expected Maxwell's law of distribution.

UNIT II: Thermodynamics

Activity: Heat Engine Efficiency Calculation

Students can work in groups to design a simple heat engine (e.g., using a syringe and a small turbine). They can measure the temperature changes and calculate the efficiency of their engine. They can compare their calculated efficiency with the theoretical Carnot efficiency to understand the limitations of real heat engines.

UNIT III: Thermodynamic Potentials and Maxwell's

Equations Activity: Thermodynamic Relations Verification

Students can solve numerical problems involving different thermodynamic potentials (internal energy, enthalpy, Helmholtz free energy, and Gibbs free energy) and verify the Maxwell's thermodynamic relations. They can compare the calculated values using different relations to ensure consistency.

UNIT IV: Low Temperature Physics

Activity: Adiabatic Demagnetization Experiment

They can discuss the distinction between adiabatic and Joule-Thomson expansions.

UNIT V: Quantum Theory of Radiation

Activity: Black Body Radiation Spectrum Analysis

They can estimate the surface temperature of the Sun using the solar constant and Angstrom pyro heliometer data.



SEMESTER-III
COURSE 7: ELECTRONIC DEVICES AND CIRCUITS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Electronic Devices and Circuits aims to provide students with a fundamental understanding of electronic devices and their applications in various circuits.

LEARNING OUTCOMES:

1. Understand the behavior of P-N junction diodes in forward and reverse bias conditions and analyze the impact of junction capacitance on diode characteristics.
2. Analyze and compare the characteristics and operation of different BJT configurations (CB, CE, and CC) and demonstrate proficiency in biasing techniques.
3. Comprehend the operation and characteristics of FETs, including JFETs and MOSFETs, and explain the working principles and characteristics of UJTs.
4. Describe the operation and applications of various photoelectric devices such as LEDs, photo diodes, phototransistors, and LDRs.
5. Understand the operation of rectifiers (half-wave, full-wave, and bridge), analyze the ripple factor and efficiency, and demonstrate knowledge of different filter types and three-terminal voltage regulators

UNIT I: PN JUNCTION DIODES

P-N junction Diode, Formation of depletion region, Forward and Reverse bias Ideal Diode, Diode equation – Reverse saturation current – Tunnel Diode- Construction, working, V-I characteristics and Applications, Zener diode – V I characteristics, Applications

UNIT –II: BIPOLAR JUNCTION TRANSISTOR AND ITS BIASING: (D.C)

Transistor construction, working of PNP and NPN Transistors, Active, Cutoff and Saturation conditions, Configurations of Transistor - CB, CE, and CC, Input and Output Characteristics of CB and CE configurations. Hybrid parameters of a Transistor and equivalent circuit, BJT Transistor Biasing – Need for stabilization, Thermal runaway, Stability factor, Biasing methods - Voltage-Divider Bias.

UNIT-III: FIELD EFFECT TRANSISTORS & POWER ELECTRONIC DEVICES –

Difference between JFET and BJT, Construction and working of JFET, Drain and Transfer Characteristics, MOSFET - Depletion-type, and Enhancement-Type MOSFETs. FET Biasing: Voltage Divider Biasing. UJT- Construction, working, V-I characteristics. SCR – Construction, Working and Characteristics



UNIT IV: PHOTO ELECTRIC DEVICES:

Light-Emitting Diodes (LEDs) - Construction, working, characteristics and Applications, IR Emitters, Photo diode - Construction, working characteristics and Applications, Phototransistors - Construction, working and characteristics, Applications, Structure and operation of LDR, Applications

UNIT-V: POWER SUPPLIES:

Rectifiers: Half wave, Full wave and bridge rectifiers - Efficiency (with derivations), ripple factor- Zener diode as Voltage Regulator, Filters- choke input (inductor), L-section, π -section filters. Three terminal fixed voltage IC-regulators (78XX and 79XX)

REFERENCE BOOKS:

1. Electronic Devices and Circuit Theory --- Robert L. Boylestad & Louis Nashelsky.
2. Electronic Devices and Circuits I – T.L.Floyd- PHI Fifth Edition
3. Integrated Electronics – Millmam & Halkias.
4. Electronic Devices & Circuits – Bogart.
5. Sedha R.S., A Text Book Of Applied Electronics, S.Chand & Company Ltd



SEMESTER-III

COURSE 7: ELECTRONIC DEVICES AND CIRCUITS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The course objectives for a practical course in Electronic Devices and Circuits might provide hands-on experience with the fundamental principles of electronic devices and circuits.

LEARNING OUTCOMES:

1. Understand the principles of electronic devices and circuits and their applications in real-world scenarios.
2. Analyze and design electronic circuits using diodes, transistors, and operational amplifiers.
3. Understand the importance of biasing and stability in electronic circuits and how to achieve them.
4. Develop the skills to design and analyze amplifier circuits and to understand the concept of feedback and its application in electronic circuits.
5. Analyze and design simple oscillators, power supplies, and filters.
6. Gain hands-on experience with electronic test equipment such as multimeters, oscilloscopes, and function generators.
7. Develop skills in circuit construction, measurement, and testing.
8. Learn how to troubleshoot and diagnose electronic circuit problems.
9. Understand the safety procedures for working with electronic circuits and equipment.

Minimum of 6 experiments to be done and recorded

1. V-I Characteristics of junction diode
2. V-I Characteristics of Zener diode
3. Transistor characteristics – CB configuration
4. Transistor characteristics – CE configuration
5. FET input and output characteristics
6. UJT characteristics
7. LDR characteristics
8. Full wave and Bridge rectifier with filters

STUDENT ACTIVITIES

UNIT I: PN Junction Diodes

Activity: V-I Characteristic Analysis

Students can analyze the V-I characteristics of a PN junction diode by using a simple circuit setup. They can measure the voltage across the diode for different values of forward and reverse bias currents and plot the corresponding current-voltage graph. They can discuss the behavior of the diode in different bias conditions.



UNIT II: Bipolar Junction Transistor and Its
Biasing Activity: Transistor Configuration
Analysis

Students can analyze the characteristics of different transistor configurations (CB, CE, CC) using a transistor tester or a circuit setup. They can measure and compare the input/output characteristics, gain, and voltage levels for each configuration. They can discuss the advantages and disadvantages of each configuration.

UNIT III: Field effect transistors & Power electronic
devices Activity: FET Transfer Characteristic Analysis

Students can analyze the transfer characteristics of a FET by measuring the drain current (I_D) for different gate-source voltages (V_{GS}). They can plot the transfer characteristic curve and observe the variations in I_D with V_{GS} . They can discuss the operation modes of FETs based on the transfer characteristics.

Unit IV: Photoelectric Devices

Activity: LED and Photodiode Circuit Demonstration

Students can set up simple LED and photodiode circuits to demonstrate their operation. They can observe the emission of light from an LED when a suitable voltage is applied and measure the current. They can also detect light using a photodiode and measure the output current for different light intensities.

UNIT V: Power Supplies

Activity: Rectifier Efficiency Calculation

Students can analyze the efficiency of different rectifier circuits (half wave, full wave, and bridge rectifiers) by measuring the input and output power. They can calculate the rectifier efficiency and compare the results for different rectifier configurations. They can discuss the factors affecting efficiency and the importance of regulation



SEMESTER-III

COURSE 8: ANALOG AND DIGITAL ELECTRONICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Analog and Digital Electronics aims to provide students with a fundamental understanding of the principles of electronic circuits and their applications in both analog and digital systems.

LEARNING OUTCOMES:

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

1. Understand Principles and Working of Operational Amplifier
2. Apply their knowledge on OP-Amp in different Applications
3. To understand the number systems, Binary codes and Complements.
4. To understand the Boolean algebra and simplification of Boolean expressions.
5. To analyze logic processes and implement logical operations using combinational logic circuits.
6. To understand the concepts of sequential circuits and to analyze sequential systems in terms of state machines

UNIT-I: OPERATIONAL AMPLIFIERS

a) Concept of feedback in CE amplifier, negative and positive feedback, advantages and disadvantages of negative feedback, Basic concepts of differential amplifier, Block diagram of op amp and its equivalent circuit, IC Diagram (IC 741), Ideal voltage transfer curve, Open loop Op-Amp configurations- differential, inverting and non-inverting Op-Amps.

b) Voltage Series Feedback Amplifier (Non-Inverting Op amp): Gain and Bandwidth derivations: Voltage Shunt Feedback Amplifier (Inverting Op amp): Gain and Bandwidth derivations

UNIT-II: PRACTICAL OPERATIONAL AMPLIFIER AND APPLICATIONS

a) Characteristics of an Ideal and Practical Operational Amplifier (IC 741), Input offset voltage, Input bias current, Input offset current, total output offset voltage, CMRR, slew rate and concept of virtual ground.

b) Applications of Op-Amp: Linear Applications: Voltage Follower, Summing Amplifier, Subtracting Amplifier, Averaging Amplifier, Difference Amplifier, Integrator and Differentiator, Square Wave response of Integrator and Differentiator (Brief explanation only)



UNIT-III: NUMBER SYSTEMS, CODES AND LOGIC GATES

a) Number Systems and Codes: Decimal, Binary, Octal and Hexadecimal number systems, conversions, Binary addition, Binary subtraction using 1's and 2's complement methods, BCD code and Gray code – Conversions

b) Logic Gates: Construction and truth tables of OR, AND, NOT gates, Universal gates – Basic construction and truth tables of NOR & NAND, Realization of logic gates using NAND and NOR, XOR and XNOR Logic gates symbol and their truth tables. De Morgan's Laws, Boolean Laws, Simplification of Boolean Expressions using Boolean Laws

UNIT-IV: ARITHMETIC CIRCUITS & DATA PROCESSING CIRCUITS

a) Half Adder and Full Adder: Explanation of truth tables and Circuits. Half Subtractor and Full Subtractor: Explanation of truth tables and Circuits, 4 - bit binary Adder/Subtractor.

b) Multiplexers - 2 to 1 Multiplexer, 4 to 1 multiplexer, De-multiplexers: 1 to 2 Demultiplexer, 1 to 4 Demultiplexer, Applications of Multiplexers and Demultiplexers Decoders: 1 of 2 decoders, 2 of 4 decoders, Encoders: 4 to 2 Encoder, 8 to 3 Encoder, Applications of decoders and encoders

UNIT-V: SEQUENTIAL LOGIC CIRCUITS & CODE CONVERTERS

a) Combinational Logic vs Sequential Logic Circuits, Sequential Logic circuits: Flip-flops, Basic NAND, NOR Latches, Clocked SR Flip-flop, JK Flip-flop, D Flip-flop, Master-Slave Flip-flop, Conversion of Flip flops.

b) Code Converters: BCD to Decimal Converter, BCD to Gray Code Converter, BCD to 7 segment Decoders

Reference Books:

1. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
2. Operational Amplifiers and Linear ICs, David A. Bell, 3rd Edition, 2011,
3. Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., TMH
4. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
5. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)
6. R. L. Tokheim, Digital Principles, Schaum's Outline Series, Tata McGraw- Hill (1994)



SEMESTER-III

COURSE 8: ANALOG AND DIGITAL ELECTRONICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVES:

The course objectives for a practical course in Analog and Digital Electronics might provide students with hands-on experience in designing, constructing, and testing analog and digital electronic circuits.

LEARNING OUTCOMES:

1. Understand the principles of analog and digital electronic circuits and their applications in real-world scenarios.
2. Analyze and design analog electronic circuits using diodes, transistors, and operational amplifiers.
3. Analyze and design digital electronic circuits using logic gates, flip-flops, and counters.
4. Understand the importance of biasing, feedback, and stability in electronic circuits and how to achieve them.
5. Develop the skills to design and analyze amplifier circuits and digital systems.

Minimum six experiments to be done and recorded.

1. To study the operational amplifier as inverting feedback amplifier with verifying gain
2. To study the operational amplifier as non-inverting feedback amplifier with verifying gain
3. To study operational amplifier as adder
4. To study operational amplifier as subtractor
5. To study operational amplifier as differentiator
6. To study operational amplifier as integrator
7. Logic Gates- OR, AND, NOT and NAND gates. Verification of Truth Tables.
8. Verification of De Morgan's Theorems.
9. Construction of Half adder and Full adders-Verification of truth tables
10. Flip flops
11. Multiplexer and De-multiplexer
12. Encoder and Decoder



STUDENT ACTIVITIES

UNIT-I: OPERATIONAL AMPLIFIERS

Circuit Analysis: Students can be asked to analyze different operational amplifier circuits such as inverting and non-inverting amplifiers, summing amplifiers, difference amplifiers, and integrators. They can be asked to calculate the gain, input and output impedance, and frequency response of the circuits.

Circuit Design: Students can be asked to design different operational amplifier circuits such as audio amplifiers, filters, and oscillators. They can be asked to select the appropriate op-amp and other components such as resistors, capacitors, and inductors to meet the desired specifications.

UNIT-II: PRACTICAL OPERATIONAL AMPLIFIER AND APPLICATIONS

Design an inverting amplifier circuit: Students can be asked to design and build an inverting amplifier circuit using an operational amplifier and a few passive components. They can then measure the gain and frequency response of the circuit using an oscilloscope and a function generator. They can also compare the measured values with the theoretical calculations and simulation results.

Build a summing amplifier circuit: Students can be asked to build a summing amplifier circuit using an operational amplifier and several input signals. They can then measure the output voltage of the circuit and compare it with the expected value. They can also investigate the effect of changing the input signal amplitudes and the resistor values on the circuit performance.

UNIT-III: NUMBER SYSTEMS, CODES AND LOGIC GATES

Convert numbers between different bases: Students can be asked to convert numbers between binary, decimal, and hexadecimal bases. They can practice converting both integer and fractional numbers, and verify their results using online conversion tools or calculators.

Design a binary adder circuit: Students can be asked to design and build a binary adder circuit using logic gates such as XOR, AND, and OR gates. They can then test the circuit by adding two binary numbers and comparing the result with the expected value.

UNIT-IV: ARITHMETIC CIRCUITS & DATA PROCESSING CIRCUITS

Design a data processing circuit: Students can be asked to design and build a data processing circuit that performs a specific function, such as filtering, modulation, or demodulation. They can use op-amps, filters, modulators, and demodulators to implement the circuit and test its performance using simulated or real-world signals.

Implement a digital signal processing algorithm: Students can be asked to implement a digital signal processing algorithm, such as a Fourier transform, a discrete cosine transform, or a digital filter. They can use software tools such as MATLAB or Python to simulate the algorithm and test its performance using sample signals.



UNIT-V: SEQUENTIAL LOGIC CIRCUITS & CODE CONVERTERS

Design a flip-flop circuit: Students can be asked to design and build a flip-flop circuit using logic gates and test its operation by creating a sequence of logic signals. They can also compare the performance of different types of flip-flops, such as SR, D, JK, and T, and discuss their advantages and disadvantages in sequential circuits.

Implement a counter circuit: Students can be asked to design and build a counter circuit that counts up or down using flip-flops. They can use different types of counters, such as ripple, synchronous, or Johnson, and test their operation by connecting the output to LEDs or other indicators.

Design a code converter circuit: Students can be asked to design and build a code converter circuit that converts a binary code to another code, such as Gray code, BCD, or ASCII. They can use logic gates, multiplexers, and decoders to implement the circuit, and test its operation by inputting different codes



ADIKAVI NANNAYA UNIVERSITY: RAJMAHENDRAVARAM

Single Major B.Sc. Physics (w.e.f:2023-24A.B)

SEMESTER-IV

COURSE 9: ELECTRICITY AND MAGNETISM

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Electricity and Magnetism aims to provide students with a fundamental understanding of the principles of electricity, magnetism, and their interactions

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, Thvenin'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

Gauss's law-Statement and its proof, Electric field intensity due to (i) 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.

UNIT-II Current electricity

Electrical conduction-drift velocity-current density, equation of continuity, ohms law and limitations, Kirchhoff's Law's, Wheatstone bridge-balancing condition - sensitivity. 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 Magneto statics

Biot-Savart's law and its applications: (i) circular loop and (ii) solenoid, Ampere's Circuital Law and its application to Solenoid, Hall effect, determination of Hall coefficient and applications.

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:

Basic laws of electricity and magnetism- Maxwell's equations- integral and differential forms Derivation, concept of displacement current. Plane electromagnetic wave equation, Hertz experiment-Transverse nature of electromagnetic waves. Electromagnetic wave equation in conducting media. Pointing vector and propagation of electromagnetic waves

UNIT-V Varying and alternating currents:

Growth and decay of currents in LR, CR, LCR circuits-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, Q -factor, Power in ac circuits, Power factor.

REFERENCE BOOKS

1. BSc Physics, Vol.3, Telugu Akademy, 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 R. Murugeshan, Kiruthiga Siva prasath, and M. Saravanapandian
6. "Electricity and Magnetism: Theory and Applications" by Ajoy Ghatak and S. Lokanathan
7. Electricity and Magnetism: Problems and Solutions" by Ashok Kumar and Rajesh Kumar
8. Electricity and Magnetism, R. Murugeshan, S. Chand & Co.



SEMESTER-IV

COURSE 9: ELECTRICITY AND MAGNETISM

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:

Demonstrate a thorough understanding of the fundamental concepts and principles of electricity and magnetism.

Apply the laws and principles of electricity and magnetism to analyze and solve electrical and magnetic problems.

Design, construct, and test electrical circuits using various components and measuring instruments.

Measure and analyze electrical quantities such as voltage, current, resistance, capacitance, and inductance using appropriate instruments.

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. Figure of merit of a moving coil galvanometer.
2. LCR circuit series/parallel resonance, Q factor.
3. Determination of ac-frequency –Sonometer.
4. Verification of Kirchhoff's laws and Maximum Power Transfer theorem.
5. Verification of Thevenin's and Norton's theorem
6. Field along the axis of a circular coil carrying current-Stewart & Gee's apparatus.
7. Charging and discharging of CR circuit-Determination of time constant
8. A.C Impedance and Power factor
9. Determination of specific resistance of wire by using Carey Foster's bridge.

STUDENT ACTIVITIES

UNIT-I Electrostatics and Dielectrics:

Conduct a simulation to visualize equipotential surfaces for a given charge distribution.

Conduct a group discussion on the significance of electric field lines and how they can be used to predict the motion of charged particles in electric fields.

UNIT-II Current electricity:

Conduct a Wheatstone bridge experiment in class and discuss the balancing condition and sensitivity.

Conduct a group activity where students are divided into groups and assigned a different circuit analysis method (nodal analysis, mesh analysis, superposition theorem, etc.) and asked to present their findings to the class.



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UNIT-III Magneto statics and Electromagnetic Induction:

Conduct a demonstration to show the Hall effect and measure the Hall coefficient of a given material.

Conduct a group activity where students are divided into groups, and assigned a different application of Faraday's law (electromagnetic induction, transformers, etc.) and asked to present their findings to the class.

UNIT-IV Electromagnetic waves:

Conduct a group activity where students are asked to research the history of the development of Maxwell's equations and present their findings to the class.

Conduct a simulation to visualize the propagation of electromagnetic waves in different media (vacuum, air, water, etc.) and discuss the differences in the behaviour of waves in different media.

UNIT-V Varying and alternating currents:

Conduct a demonstration to show the resonance in an LCR circuit and measure the Q-factor.

Conduct a group activity where students are divided into groups and assigned a different power factor correction method (capacitor banks, synchronous condensers, etc.) and asked to present their findings to the class.



COURSE 10: MODERN PHYSICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course on Modern Physics aims to provide students with an understanding of the principles of modern physics and their applications in various fields.

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 structure and spectroscopy
3. Develop critical understanding of concept of Matter waves and Uncertainty principle.
4. Get familiarized with the principles of quantum mechanics and the formulation of Schrodinger wave equation and its applications.
5. Increase the awareness and appreciation of superconductors and their practical applications

UNIT-I: Introduction to Atomic Structure and Spectroscopy:

Bohr's model of the hydrogen atom -Derivation for radius, energy and wave number - Hydrogen spectrum, Vector atom model – Stern and Gerlach experiment, Quantum numbers associated with it, Coupling schemes, Spectral terms and spectral notations, Selection rules. Zeeman effect, Experimental arrangement to study Zeeman effect.

UNIT-II: Molecular Structure and Spectroscopy

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, UV-Visible, and Raman spectroscopy

UNIT-III: Matter waves & Uncertainty Principle:

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: Quantum Mechanics:

Basic postulates of quantum mechanics, Schrodinger time independent and time dependent wave equations- Derivations, Physical interpretation of wave function, Eigen functions, Eigen values, Application of Schrodinger wave equation to (one-dimensional potential box of infinite height (Infinite Potential Well)



UNIT-V: Superconductivity:

Introduction to Superconductivity, Experimental results-critical temperature, critical magnetic field, Meissner effect, London's Equation and Penetration Depth, Isotope effect, Type I and Type II superconductors, BCS theory, high T_c super conductors, Applications of superconductors

REFERENCE BOOKS

1. BSc Physics, Vol.4, Telugu Akademy, 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, D.C.Tayal, Himalaya Publishing House.
6. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publ.Co.)
7. K.K.Chattopadhyay & A.N.Banerjee, Introd.to Nanoscience and Technology (PHI Learning Priv. Limited).
8. Nano materials, A K Bandopadhyay. New Age International Pvt Ltd (2007)
9. Textbook of Nanoscience and Nanotechnology, BS Murthy, P Shankar, Baldev Raj, BB Rath and J Murday-Universities Press-IIM



SEMESTER-IV

COURSE 10: MODERN PHYSICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The course objective for a practical course in Modern Physics may provide hands-on experience with experimental techniques and equipment used in modern physics experiments.

LEARNING OUTCOMES:

1. Apply experimental techniques and equipment to investigate and analyze phenomena related to modern physics, such as quantum mechanics, relativity, atomic physics, and nuclear physics.
2. Demonstrate a deep understanding of the principles and theories of modern physics through hands-on experimentation and data analysis.
3. Develop proficiency in using advanced laboratory instruments and techniques specific to modern physics experiments, such as spectroscopy, interferometry, particle detectors, and radiation measurement.
4. Analyze and interpret experimental data using statistical methods and error analysis, drawing meaningful conclusions and relating them to theoretical concepts.
5. Design and conduct independent experiments or investigations related to modern physics, demonstrating the ability to plan, execute, and analyze experimental procedures and results.

Minimum of 6 experiments to be done and recorded

1. e/m of an electron by Thomson method.
2. Determination of Planck's Constant (photocell).
3. Verification of inverse square law of light using photovoltaic cell.
4. Determination of the Planck's constant using LEDs of at least 4 different colours.
5. Determination of work function of material of filament of directly heated vacuum diode.
6. Determination of M & H.
7. Energy gap of a semiconductor using junction diode.
8. Energy gap of a semiconductor using thermistor.

STUDENT ACTIVITIES:

UNIT-I: Introduction to Atomic Structure and Spectroscopy

Spectroscopy Experiment:

Divide the students into small groups and provide each group with a spectrometer or spectroscope, a light source, and different samples or elements for analysis.

Instruct the students to carefully observe the spectra produced by the samples using the spectrometer. Encourage them to note the presence of specific spectral lines or patterns.

Data Collection:

Have the students record their observations in their lab notebooks or worksheets. They should note the wavelengths or colors of the observed spectral lines and any patterns they observe.

Analysis and Discussion:

Guide a class discussion on the observed spectra and their significance. Discuss how the observed spectral lines correspond to specific energy transitions in the atoms.

Ask students to compare the spectra of different samples or elements and identify any similarities or differences.

Discuss the concept of energy levels and how electrons transition between them, emitting or absorbing photons of specific wavelengths.



UNIT-II: Molecular Structure and Spectroscopy

Begin the activity with a brief introduction to molecular structure, discussing concepts such as chemical bonds, molecular geometry, and the importance of molecular structure in determining the properties and behavior of substances.

Explain the principles of spectroscopy, focusing on vibrational and rotational spectra and how they relate to molecular vibrations and rotations.

UNIT-III: Matter waves & Uncertainty Principle:

Begin the activity by introducing the concept of matter waves and the uncertainty principle. Discuss how the wave-particle duality of matter is a fundamental principle in quantum mechanics.

Provide a brief overview of the historical development of the uncertainty principle and its implications for our understanding of the behavior of particles on a microscopic scale.

UNIT-IV: Quantum Mechanics:

Begin the activity by providing an overview of quantum mechanics and its significance in understanding the behavior of particles on a microscopic scale. Discuss key concepts such as wave-particle duality, superposition, quantization, and the probabilistic nature of quantum systems

UNIT-V: Superconductivity:

Begin the activity by providing an overview of superconductivity, including its definition, properties, and significance in scientific and technological applications.

Discuss key concepts such as zero electrical resistance, Meissner effect, critical temperature, and type I and type II superconductors



COURSE 11: INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The course aims to provide students with an understanding of the principles of Nuclear and Particle physics and their applications in various fields.

LEARNING OUTCOMES

By successful completion of the course, students will be able to

1. know about high energy particles and their applications which prepares them for further study and research in elciirap physics
2. Students can explain important concepts on nucleon-nucleon interaction, such as its short-range, spin dependence, isospin, and tensors.
3. Students can show the potential shapes from nucleon nucleon interactions.
4. Students can explain the single particle model, its strengths, and weaknesses
5. Students can explain magic numbers based on this model

UNIT-I: Introduction to Nuclear Physics

Nuclear Structure: General Properties of Nuclei, Mass defect, Binding energy; Nuclear forces: Characteristics of nuclear forces- Yukawa's meson theory; Nuclear Models- Liquid drop model- Semi empirical mass formula, nuclear shell model.

UNIT-II: Elementary Particles and Interactions

Discovery and classification of elementary particles, properties of leptons, mesons and baryons; Types of interactions- strong, electromagnetic and weak interactions; Conservation laws – Isospin, parity, charge conjugation

UNIT-III: Nuclear Reactions and Nuclear Detectors

Nuclear Reactions: Types of reactions, Conservation Laws in nuclear reactions, Reaction energetic, Threshold energy, nuclear cross-section; Nuclear detectors: Geiger- Muller counter, Scintillation counter, Cloud chamber



UNIT-IV: Nuclear Decays and Nuclear Accelerators

Nuclear Decays: Gamow's theory of alpha decay, Fermi's theory of Beta- decay, Energy release in Beta-decay, selection rules. Nuclear Accelerators: Types- Electrostatic and electrodynamics accelerators; Cyclotron-construction, working and applications; Synchrocyclotron-construction, working and applications.

UNIT-V: Applications of Nuclear and Particle Physics

Medical Applications: Radiation therapy and imaging techniques, nuclear energy: nuclear reactors and power generation, Particle physics in high-energy Astro Physics

Reference Books:

1. Nuclear Physics, Irving Kaplan, Narosa Pub. (1998).
2. Nuclear Physics, Theory and experiment – P.R. Roy and B.P. Nigam, New Age Int.1997.
3. Atomic and Nuclear Physics (Vol.2), S.N. Ghoshal, S. Chand & Co. (1994).
4. Nuclear Physics, D.C. Tayal, Himalaya Pub. (1997).
5. Atomic and Nuclear Physics, R.C. Sharma, K. Nath& Co., Meerut.
6. Nuclei and Particles, E. Segre.
7. Introduction to Nuclear Physics, H.A. Enge, Addison Wesley (1975).



SEMESTER-IV

COURSE 11: INTRODUCTION TO NUCLEAR AND PARTICLE PHYSICS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

To familiarize students with experimental techniques and methodologies used in nuclear and particle physics.

To provide hands-on experience in conducting experiments related to nuclear and particle physics.

LEARNING OUTCOMES:

1. Gain a solid understanding of fundamental concepts in nuclear and particle physics.
2. Acquire knowledge of experimental techniques and methodologies used in the field.
3. Understand the principles and operation of laboratory equipment and instruments specific to nuclear and particle physics experiments.
4. Develop proficiency in conducting experiments related to nuclear and particle physics.
5. Acquire skills in data acquisition, analysis, and interpretation using appropriate software and techniques.
6. Learn to design and perform experiments, including calibration, measurement, and control of variables.

NSINRPTNEEX EPXE

1. GM counter – Determination of dead time
2. eiacl oc rilclripcliiir racop oc se roacipc lcc piiiolioc oc iii oepcliict ooailtp
3. riiolioc oc pcciripcll coc l tlool ioacrp oc iip se roacipc
4. ro opclcl icopcip ilalcp alw aiict se roacipc
5. fcocariioc lcc liipcaliioc ocbremssstrahlung
6. riiolioc oc pcciripcll coc l bpil ioacrp oc iip se roacipc
7. eiacl oc blre irliipcict oc bpil elciirapi

STUDENT ACTIVITIES

UNIT-I: INTRODUCTION TO NUCLEAR PHYSICS

Provide students with a computer simulation or interactive app that allows them to explore radioactive decay processes.

Ask students to observe and analyze the decay patterns of different isotopes, including the concept of half-life.

Guide students to make connections between the simulation results and the fundamental principles of nuclear physics



UNIT-II: ELEMENTARY PARTICLES AND INTERACTIONS

Divide students into small groups and assign each group a specific elementary particle (e.g., proton, electron, neutrino, quark).

Instruct students to create a poster showcasing their assigned particle, including its properties, classification, and interactions.

Encourage creativity in the presentation of information, such as diagrams, illustrations, and concise explanations.

Have each group present their posters to the class, promoting discussion and comparisons between different particles.

UNIT-III: NUCLEAR REACTIONS AND NUCLEAR DETECTORS

Divide students into small groups and assign each group a specific scenario that requires radiation shielding, such as a nuclear power plant, a medical facility, or a space mission.

Instruct students to research and design an effective radiation shielding system for their assigned scenario, considering factors such as the type of radiation, the intensity of radiation, and the materials available for shielding.

Encourage students to calculate and compare the attenuation properties of different materials and discuss the trade-offs between effectiveness, cost, and practicality in their designs.

Have each group present their shielding design to the class, explaining their rationale and addressing potential challenges or limitations

UNIT-IV: NUCLEAR DECAYS AND NUCLEAR ACCELERATORS

Provide students with a radioactive decay chain involving multiple decays, such as alpha decay, beta decay, and gamma decay.

Instruct students to analyze the decay chain and determine the sequence of decays, including the types of particles emitted and the resulting daughter nuclei.

Ask students to calculate the half-lives of the parent and daughter nuclei based on the decay data and explore the concept of radioactive equilibrium.

Encourage students to discuss the practical applications and significance of decay chains in fields such as radiometric dating or medical imaging

UNIT-V: APPLICATIONS OF NUCLEAR AND PARTICLE PHYSICS

Assign students specific medical imaging techniques based on nuclear and particle physics, such as positron emission tomography (PET), single-photon emission computed tomography (SPECT), or computed tomography (CT).

Instruct students to research and present on the principles behind their assigned imaging technique, including the interaction of particles or radiation with matter, detector technology, and image reconstruction methods.

Ask students to discuss the advantages, limitations, and specific medical applications of their assigned imaging technique.

Encourage students to critically analyze the role of nuclear and particle physics in advancing medical diagnostics and treatment planning



SEMESTER-V

COURSE 12: APPLICATIONS OF ELECTRICITY AND MAGNETISM

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Applications of Electricity and Magnetism is to provide students with a comprehensive understanding of the practical applications of electricity and magnetism in various fields. The course aims to develop students' knowledge and skills in applying electrical and magnetic principles to real-world problems and technologies.

LEARNING OUTCOMES:

Students after successful completion of the course will be able to:

1. Identify various components present in Electricity & Electronics Laboratory.
2. Acquire a critical knowledge of each component and its utility (like resistors, capacitors, inductors, power sources etc.).
3. Demonstrate skills of constructing simple electronic circuits consisting of basic circuit elements.
4. Understand the need & Functionality of various DC & AC Power sources.
5. Comprehend the design, applications and practices of various electrical & Electronic devices and also their trouble shooting.

Unit-I: Introduction to Passive Elements

a) Passive elements

Resistor - Types of Resistors, Color coding, Combination of Resistors – Series combination (Voltage division), Parallel combination (Current division), Ohms Law and its limitation. Inductor - Principle, EMF induced in an Inductor, Energy stored in Inductor, Phase relation between V and I, Combinations of Inductors, Types of Inductors. Capacitor - Principle, Charging and discharging of a Capacitor, Types of Capacitors, Color coding

b) Applications of Passive elements:

Applications of a Resistor as a heating element in heaters and as a fuse element. Open circuit, Short circuit, Applications of Inductors, Application of choke in a fan and in a radio tuning circuit, Series resonance circuit as a Radio tuning circuit. Applications of Capacitor in power supplies, motors (Fans) etc.

Unit-II Power Sources (Batteries)

a) Power sources:

Types of power sources-DC & AC sources, Different types of batteries, Rechargeable batteries –Lead acid batteries, Li-ion batteries **Series, Parallel & Series-Parallel configuration of batteries**,

b) Network Theorems for DC circuits

Thevenin's theorem, Norton's theorem, Maximum Power transfer theorem, Constant Voltage source- Constant Current Source-Applications of Current sources & Voltage sources, SMPS used in computers.



Unit-III Alternating & Direct Currents

A.C Generator, Construction and its working principle, Types of AC Generators, DC Generator, Construction and its working principle, advantages and disadvantages, Applications, Types of DC Generators, Losses associated with DC generators, Differences between DC and AC generators

- a) Transformers- Construction and its working principle, EMF equation, Open circuit and short circuit tests, Types of Transformers - Step-down and Step-up Transformers, Relation between primary turns and secondary turns of the transformer with emf, Use of a Transformer in a regulated Power supplies, Single phase motor – working principle, Applications of motors (like water pump, fan etc).

Unit-IV Modulation Circuits

- a) Need for modulation, Types of modulation, Amplitude modulation, modulation index, Waveforms, Power relations, Demodulation, Diode detector, AM transmitter, AM Receiver, Frequency modulation, modulation index, Waveforms, FM Transmitter, FM Receiver

b) Transmitters and Receivers:

AM transmitter, AM Receiver, Frequency modulation, modulation index, Waveforms, FM Transmitter, FM Receiver

Unit-V Applications of EM Induction & Power Supplies

- a) DC motor – Construction and operating principle, Calculation of power, voltage and current in a DC motor, Design of a simple Motor (for example Fan) with suitable turns of coil
- b) Working of a DC regulated power supply, Construction of a 5 volts regulated power supply, Design of a step-down (ex:220-12V) and step-up (ex:120-240V) transformers-Simple Design of FM Radio circuit using LCR series resonance (tuning) circuit, Checking the output voltage of a battery eliminator using a Multimeter. (Trouble shooting), Design of a simple 5 volts DC charger, Power supply for computers (SMPS)

References:

1. Grob's Basic Electronics by Mitchel Schultz , TMH or McGraw Hill
2. Electronic and Electrical Servicing by Ian Robertson Sinclair, John Dunton, Elsevier Publications
3. Troubleshooting Electronic Equipment by R.S.Khandapur ,TMH
4. Web sources suggested by the teacher concerned and the college librarian including reading material.



SEMESTER-V
COURSE 12: APPLICATIONS OF ELECTRICITY AND MAGNETISM

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The objective of the practical course on Applications of Electricity and Magnetism is to provide students with hands-on experience and practical skills in applying electrical and magnetic principles to real-world applications. The course aims to develop students' proficiency in working with electrical circuits, electromagnetic devices, and related technologies through practical experimentation and project-based activities.

LEARNING OUTCOMES:

On successful completion of this practical course, students shall be able to:

1. List out, identify and handle various equipment in Electrical & Electronics laboratory.
2. Learn the procedures of designing simple electrical circuits.
3. Demonstrate skills on the utility of different electrical components and devices.
4. Acquire the skills regarding the operation, maintenance and troubleshooting of various Devices in the lab.
5. Understand the different applications of Electromagnetic induction.

Practical (Laboratory) Syllabus:

1. Acquainting with the soldering techniques
2. Design and Construction of a 5 Volts DC unregulated power supply
3. Construction of a Step down Transformer and measurement of its output voltage.
And to compare it with the calculated value.
4. Connect two or three resistors or capacitors or inductors and measure the Series, Parallel Combination values using a Multimeter and compare the values with the Calculated values.
5. Use the Digital Multimeter and Analog Multimeter to measure the output voltage of an AC & DC power supply and also the voltage and frequency of a AC signal using CRO.
6. Use the Multimeter to check the functionality of a Diode and Transistor. Also test whether the given transistor is PNP or NPN.
7. Construct a series electric circuit with R, L and C having an AC source and study the frequency response of this circuit. Find the Resonance Frequency.
8. Construct a Parallel electric circuit with R, L & C having an AC source and study the frequency response of this circuit .Find the resonant frequency.
9. Test whether a circuit is a Open circuit or Short Circuit by measuring continuity with a Multimeter and record your readings.



I. Lab References:

1. Laboratory Manual for Introductory Electronics Experiments by Maheshwari, L.K. Anand, M.M.S., New Age International (P) Ltd.
2. Electricity-Electronics Fundamentals: A Text-lab Manual by Paul B. Zbar, Joseph Sloop, & Joseph G. Sloop, McGraw-Hill Education
3. Laboratory Manual Basic Electrical Engineering by Umesh Agarwal, Notion Press
4. Basic Electrical and Electronics Engineering by S.K. Bhattacharya, Pearson Publishers.
5. Web sources suggested by the teacher concerned.

STUDENT ACTIVITIES

Co-Curricular Activities:

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field: 05)*

1. **For Teacher:** Training of students by the teacher (if necessary, by a local expert) in laboratory/field for not less than 15 hours on the understanding of various electronic &electrical components and devices. And also understand the functional knowledge of these components and devices so that the student can safely handle these electronic components.
2. **For Student:** Students shall (individually) visit local Radio, TV or Mobile repair shop to understand the testing and soldering techniques and different electronic components in the devices that we use daily life. And also to understand the troubleshooting and working of domestic appliances such as cell phone chargers, fan, electric iron, heater, inverter, micro oven, washing machine etc. (Or) Students shall also visit the Physics/Electronics or Instrumentation Labs of nearby local institutions and can get additional knowledge by interacting with the technical people working there. (Or) Students shall also visit the local motor winding shop to understand the motor winding and working of different types of motors. After the observations, a hand- written Fieldwork/Project work not exceeding 10 pages in the given format to be submitted to the teacher.
3. Max marks for Fieldwork/Project work: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
5. Unit tests (IE).

(b) Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying various electrical and electronic components &devices and their handling, operational techniques with safety and security)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in Electrical & Electronic Appliances in daily life.
5. Collection of material/figures/photos related to Electrical products like Heaters, Motors, Fans etc. and writing and organizing them in a systematic way in a file.
6. Visits to nearby electrical or electronic industries or laboratories in universities, research organizations, private firms, etc.
7. Invited lectures and presentations on related topics by field/industrial experts



SEMESTER-V
COURSE 13: ELECTRONIC INSTRUMENTATION

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Electronic Instrumentation is to provide students with a comprehensive understanding of various electronic instruments used for measurement, data acquisition, and control applications. The course aims to develop students' knowledge and skills in the design, operation, calibration, and application of electronic instruments.

LEARNING OUTCOMES:

Students after successful completion of the course will be able to:

1. Identify various facilities required to set up a basic Instrumentation Laboratory.
2. Acquire a critical knowledge of various Electrical Instruments used in the Laboratory.
3. Demonstrate skills of using instruments like CRO, Function Generator, Multimeter etc. through hands on experience.
4. Understand the Principle and operation of different display devices used in the display systems and different transducers
5. Comprehend the applications of various biomedical instruments in daily life like B.P. meter, ECG, Pulse oximeter etc. and know the handling procedures with safety and security.

UNIT-I Introduction to Instruments

(a) Basic of measurements:

Instruments accuracy, precision, sensitivity, resolution, range, errors in measurement, Classification of Instruments, Analog instruments & Digital Instruments, Construction and working of an Analog Multimeter and Digital Multimeter (Block diagram approach), DC Voltmeter and AC Voltmeter, Sensitivity, 3½ display and 4½ display Digital Multimeter, Sources of errors in the Measurement of resistance, voltage and current, Specifications of Multimeter and their significance.

(b) Balancing and damping Moving iron instruments & PMMC instruments.

UNIT-II Oscilloscope

- a) Cathode ray oscilloscope – Principle and block diagram of CRO - Cathode Ray Tube – functioning – various controls
- b) Applications CRO: Measurement of voltage (dc and ac), frequency & time period, Different types of oscilloscopes and their uses, Digital storage Oscilloscope

UNIT-III Transducers and Bridges

- a) Linear Variable Differential Transformer (LVDT), Resistive, Capacitive & Inductive transducers, Piezo-electric transducer.
- b) DC Bridge -Wheatstone's bridge, AC Bridges - Measurement of Inductance and Capacitance – Maxwell's bridge, Schering Bridge, Measurement of frequency – Wien's bridge.



UNIT-IV ADC and DAC & Display Instruments

- a) A/D & D/A converters - Binary ladder, A/D converters –successive approximation type.
- b) Introduction to Display devices, LED Displays, Seven Segment Displays, Construction and operation (Display of numbers), Types of SSDs (Common Anode & Common Cathode type), Limitations of SSDs, Liquid Crystal Displays, Principle and working, Applications of LCD modules.

UNIT-V Amplifiers, Oscillators & Biomedical Instruments

- a) Amplifiers – Classification of amplifiers, Coupling amplifiers – RC Coupled amplifier – frequency response characteristics (no derivation), Feedback in Electronic circuits – Positive and Negative feedback, expressions for gains, advantages of negative feedback, Barkhausen criteria, RC phase shift oscillator.
- b) Basic operating principles and uses of (i) ECG machine (ii) Radiography (iii) Ultrasound scanning (iv) Ventilator (v) Pulse oximeter.

REFERENCE BOOKS:

1. Electronic Instrumentation by H.S.Kalsi ,TMH Publishers
2. Electronic Instrument Hand Book by Clyde F. Coombs ,McGraw Hill
3. Introduction to Biomedical Instrumentation byMandeep Singh, PHI Learning.
4. Electronic Instrumentation – WD Cooper
5. Electrical and Electronic Instrumentation – AK Sawhany
6. A text book in electrical technology by B.L.Thereja (S.Chand&Co)
7. *Biomedical Instrumentation and Measurements* by Leslie Cromwell ,Prentice Hall India.
8. Electronic Measurements and Instrumentation by Kishor, K Lal, Pearson, New Delhi
9. Electrical and Electronic Measurements by Sahan, A.K., Dhanpat Rai, New Delhi
10. Electronic Instruments and Measurement Techniques by Cooper, W.D. Halfrick, A.B., PHI Learning, New Delhi
11. Web sources suggested by the teacher concerned and the college librarian including reading material.



SEMESTER-V

COURSE 13: ELECTRONIC INSTRUMENTATION

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The objective of the practical course on Electronic Instrumentation is to provide students with hands-on experience in using electronic instruments for measurement, data acquisition, and control applications. The course aims to develop students' practical skills in operating, calibrating, and troubleshooting electronic instruments commonly used in scientific, engineering, and industrial settings.

LEARNING OUTCOMES:

1. Familiarize students with a range of electronic instruments, including multimeters, oscilloscopes, signal generators, and data acquisition systems.
2. Learn the basic operation, functions, and features of each instrument.
3. Gain hands-on experience in connecting, configuring, and using different instruments for various measurement tasks.
4. Develop proficiency in performing common electrical measurements, such as voltage, current, resistance, frequency, and temperature measurements.
5. Learn specialized measurement techniques, including impedance measurements, time and frequency measurements, and power measurements.
6. Gain practical experience in selecting appropriate measurement techniques and instruments for specific applications.

PRACTICAL SYLLABUS

1. Familiarization of digital multimeter and its usage in the measurements of (i) resistance (ii) current, (iii) AC & DC voltages
2. Measure the AC and DC voltages, frequency using a CRO and compare the values measured with other instruments like Digital multimeter.
3. Formation of Sine, Square wave signals on the CRO using Function Generator and measure their frequencies. Compare the measured values with actual values.
4. Display the numbers from 0 to 9 on a single Seven Segment Display module by applying voltages.
5. Displacement transducer-LVDT
6. A.C - Impedance and Power Factor.
7. Maxwell's Bridge – Determination of Inductance.
8. Measurement of body temperature using a digital thermometer and list out the error and corrections.
9. Measurement of Blood Pressure of a person using a B.P. meter and record your values and analyze them.
10. Display the letters **a** to **h** on a single Seven Segment Display module by applying voltages.



11. Get acquainted with an available ECG machine and study the ECG pattern to understand the meaning of various peaks
12. Observe and understand the operation of a Digital Pulseoxymeter and measure the pulse rate of different people and understand the working of the meter.

VI. Lab References:

1. Electronic Measurement and Instrumentation by J.P. Navani. ,S Chand & Co Ltd
2. Principles of Electronic Instrumentation by A De Sa, Elsevier Science Publ.
3. Electronic Measurements and Instrumentation by S.P.Bihari, YogitaKumari, Dr. Vinay Kakka, Vayu Education of India .
4. Laboratory Manual For Introductory Electronics Experiments by Maheshwari, New Age International (P) Ltd., Publishers.
5. Electricity-Electronics Fundamentals: A Text-lab Manual by Paul B. Zbar ,Joseph Sloop, & Joseph G. Sloop , McGraw-Hill Education.
6. Web sources suggested by the teacher concerned.

STUDENT ACTIVITIES

Co-Curricular Activities

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field:05)*

1. For Teacher: Training of students by the teacher in the laboratory/field for not less than 15 hours on the field techniques/skills of understanding the operation, Maintenance and utility of various electrical and electronic instruments both in the Laboratory as well as in daily life.

For Student: Students shall (individually)visit a local electrical and electronics shop or small firm to familiarize with the various electrical and electronic instruments available in the market and also to understand their functionality, principle of operation and applications as well as the troubleshooting of these instruments.(Or) Student shall visit a diagnostic center and observe the ECG machine and the ECG pattern(Or) Student shall visit a diagnostic center and observe the CT scan and MRI scan.(Or) Student shall visit a mobile smart phone repair shop and observe the different components on the PCB(Motherboard), different ICs (chips) used in the motherboard and trouble shooting of touch screen in smart phones.

Observations shall be recorded in a hand-written Fieldwork/Project work not exceeding 10 pages in the given format to be submitted to the teacher.

2. Max marks for Fieldwork/Project work: 05.
3. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
4. Unit tests (IE)



(b) Suggested Co-Curricular Activities

1. Training of students by related industrial / technical experts.
2. Assignments (including technical assignments like identifying different measuring instruments and tools and their handling, operational techniques with safety and security).
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Making your own stethoscope at home.
5. Making seven segment display at home.
6. Preparation of videos on tools and techniques in various branches of instrumentation.
7. Collection of material/figures/photos related to products of Measuring Instruments, Display Modules and Biomedical Instruments and arrange them in a systematic way in a file.
8. Visits to Instrumentation Laboratories of local Universities or Industries like Cement, Chemical or Sugar Plants etc. or any nearby research organizations, private firms, etc.
9. Invited lectures and presentations on related topics by Technical /industrial experts



SEMESTER-V
COURSE 14A: OPTICAL INSTRUMENTS AND OPTOMETRY

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Optical Instruments and Optometry is to provide students with a comprehensive understanding of the principles, design, and application of optical instruments used in various fields, with a specific focus on optometry

LEARNING OUTCOMES:

Students at the successful completion of the course will be able to:

1. Understand the construction and working principles of various optical instruments used in daily life.
2. Acquire a critical knowledge on the various defects of eye and their correcting methods with suitable lenses.
3. Demonstrate skills of using biological microscope through hands on experience.
4. Understand the various techniques used in optometry and computer based eye testing.
5. Comprehend the various applications of microscopes and telescopes.

UNIT-I Optical Microscopes

Simple Microscope-Construction, Magnifying power, normal adjustment; Compound Microscope-Construction, Magnifying power, normal adjustment, Phase contrast microscope-Operating principle, travelling microscope-Construction, working and uses

UNIT-II Telescopes

Refracting Telescopes and Reflecting telescopes, Construction, working and magnifying power of Astronomical Telescope and Terrestrial Telescopes, Binoculars – working principle and applications.

UNIT-III Applications Of Optical Instruments

Introductory ideas and applications of various microscopes *viz.*, (i) Optical microscopes (Compound microscope, Stereo microscope, Confocal microscope) (ii) Electron microscopes (TEM, SEM), (iii) Scanning Probe microscope (iv) Scanning Acoustic microscope and (v) X-ray microscope. Introductory ideas and applications of various telescopes *viz.*, (i) Optical telescopes (ii) Radio telescopes (iii) Solar telescopes (iv) Infrared telescope (v) Ultraviolet telescope



UNIT-IV Optical Vision

Introduction to optical Vision, Eye as an optical instrument, Formation of image in the eye and the camera, Ophthalmic lenses, Myopia and Hypermetropia defects, Removal of defects in vision using ophthalmic lenses, Contact lenses-Working principle, Different types of Contact lenses.

UNIT-V Ophthalmic Techniques and Optometry

Ophthalmoscope and keratometer and their working principles, Evaluation of eye disorders, Guidelines for standardized eye chart preparation, Simple phoropter and its working principle and its uses, Principles of Computer based eye testing

Reference Books

1. Optics and Optical Instruments: An Introduction by B. K. Johnson, Dover Publications.
2. Modern Optical Instruments and their construction by or ford Henry-Publisher: Biblio Life, LLC.
3. A Text Book of Optics by Brj Lal and N.Subramanyam, S.Chand & Co.
4. Practical Optics by Menn Naftly, Elsevier Science Publishing.
5. Applications of Optics in daily life | CK-12 Foundation. <https://flexbooks.ck12.org>
6. Web sources suggested by the teacher concerned and the college librarian including Reading material.



SEMESTER-V
COURSE 14 A: OPTICAL INSTRUMENTS AND OPTOMETRY

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The objective of the practical course on Optical Instruments and Optometry is to provide students with hands-on experience and practical skills in the operation, calibration, and application of optical instruments used in optometry

Learning Outcomes:

On successful completion of this practical course, student shall be able to:

1. List out, identify and handle various equipment like binoculars, telescopes and microscopes.
2. Learn the procedures of operation of various optical instruments.
3. Demonstrate skills on testing the power of lenses, improving the resolution of telescopes and microscopes.
4. Acquire skills in observing and measuring the power, focal length and different refractive errors of eye.
5. Perform some techniques related to testing the blood and other biological samples.
6. Understand the technique of operation of Computer eye testing and evaluation.

7.

Practical (Laboratory) Syllabus:

1. Evaluation of magnifying power of simple microscope.
2. Measurement of reflection and transmission coefficient of certain materials using a microscope.
3. Resolving power of telescope
4. Determination of radii of different capillary tubes using travelling microscope.
5. Refractive index of a liquid (water) using (i) concave mirror and (ii) convex lens and a plane mirror.
6. Removal of refractive errors of eye using combination of lenses.
7. Determination of power of a convex lens by finding its focal length.

Lab References:

1. A Practical Guide to Experimental Geometrical Optics by Yuriy A. Garbovskiy- Cambridge Univ. Press
2. <https://physics.columbia.edu/sites/default/files/content/Lab%20Resources/1292%20Lab%20Manual.pdf>
3. https://www.lnmiiit.ac.in/Department/Physics/uploaded_files/lab-manual.pdf
4. Basic Optics Experiments -<http://www.phys.unm.edu> › Optics Lab › Basics
5. A Practical Guide to Experimental Geometrical Optics by Yuriy A. Garbovskiy, Anatoliy V. Glushchenko, Cambridge Univ. Press
6. Web sources suggested by the teacher concerned.
http://www.phy.olemiss.edu/~thomas/weblab/Optics_lab_Items/Telescope_Microscope_PROCED_Spring_2018.pdf



STUDENT ACTIVITIES

Co-Curricular Activities

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field:05)*)

1. **For Teacher:** Training of students by the teacher (if necessary, by a local expert) in laboratory/field for a total of not less than 15 hours on the field techniques/skills on the familiarization of various optical instruments available in the laboratory; construction of different types of telescopes and their comparison in construction, operation and their utility and limitations; the details of construction of eye and various defects in the eye sight, emerging techniques in the design of eye lenses including contact lenses and making the student to understand on the testing of a biological sample using a clinical microscope

For Student: Students shall (individually) visit and observe the functioning of optical instruments at any one of the following places /centers like (a) pathological laboratory **or** a local ophthalmologist **or** (c) a local optician to understand the various types of eye lenses **or** (d) a local computer based eye testing center **or** (e) an optician, who fixes contact lenses **or** (f) a local cinema theatre **or** (g) a planetarium. Student shall write the observations and submit a hand-written Fieldwork/Project work not exceeding 10 pages in the given format to the teacher.

2. Max marks for Fieldwork/Project work: 05.
3. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
4. Unit tests (IE).

(b) Suggested Co-Curricular Activities

1. Training of students by related industrial experts.
2. Assignments (including technical assignments like identifying tools in the lens grinding, frame fitting, lens cleaning culture and other operational techniques with safety and security, IPR)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in optical instruments and optical lenses, contact lenses.
5. Making a model microscope and measuring its magnification.
6. Making a simple astronomical telescope using two convex lenses.
7. Checking the power of your spectacles or lenses at home.
8. Students shall take up making their own (i) Telescope and (ii) Binoculars with the accessories available at home.

<https://paks.org.pk/science-experiments/physics-experiments/how-to-make-astronomical-telescope>

<https://kids.nationalgeographic.com/nature/article/make-a-telescope>

<https://learning-center.homesciencetools.com/article/how-to-make-a-telescope-optical-science-project/>

<http://scipop.iucaa.in/Amateurs/telemaking.html>

9. Collection of material/figures/photos related to various types of lenses and their power.
10. Visit to any eye research laboratories, if available
11. Invited lectures and presentations on related topics by field/industrial experts



SEMESTER-V
COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Optical Imaging and Photography is to provide students with a comprehensive understanding of the principles, techniques, and applications of optical imaging and photography. The course aims to develop students' theoretical knowledge and practical skills in capturing, processing, and interpreting images using optical devices and imaging technologies.

LEARNING OUTCOMES:

Students after successful completion of the course will be able to:

1. Identify the different types of cameras and camera lenses according to different purposes.
2. Identify and understand the focal length of the different types of lenses
3. Acquire a critical knowledge on natural and artificial sources of light and their application in photography.
4. Demonstrate skills of camera usage especially Digital Cameras. To understand the various Image development and editing techniques.
5. Comprehend the concept of different types of common shooting techniques.

Unit-I: Introduction to Photography:

Working principle of a camera, Image formation in simple camera and human eye, Types of cameras Pin-hole camera , Single Lens Reflex (SLR) camera, Twin Lens Reflex (TLR) camera , Digital Single-lens reflex camera (DSLR), Digital camera, Drone flying cameras, Care and maintenance of camera.

Unit-II: Digital Photography:

Different types of Digital cameras and their parts, Working of DSLR camera, Types of lenses- Normal, Wide angle, telephoto, Zoom lenses, Digital Image formation, Digital camera image sensors, Size of the image, Depth of focus, Depth of field, Exposure time, Aperture, Shutter speed, ISO, filters, knowledge on pixels and their uses, resolution.

Unit-III: Photographic Light Sources:

Need for the light in photography, Light sources- Natural light, Sun light, Moon light, Ambient light, Artificial light sources-Flood light, Spot light, Halogen light, Halogen flash light, Digital lights, Exposure, Studio photography

Unit-IV: Photographic Shooting Techniques:

Significance and role of Camera lens in photo shooting, Arrangement of lenses in a Camera-Positioning, Techniques involved in the use of DSLR cameras, Usage of Filters, Techniques of Photomicrography, High speed Photography with motor driven camera, Basic ideas on Underwater

Photography, Medical Photography, Astronomical Photography.



Unit-V : Photo Manipulation :

Developing and printing the photographs, equipment and materials used in developing and printing, image mixing and printing, Image editing through image editing software's like Adobe Photoshop – Adjustment of Brightness, Contrast, Tonal and Colour Values, Methods of storing and processing, Image transportation through Pendrive, CD, HDD and CLOUD [Internet]

III Reference Books:

1. Object and image; An introduction to photography by George M Craven, PHI
2. An Introduction to Digital Photo Imaging Agfa, 1994
3. Advance Photography by M. Langford.
4. Digital Photography-A hands on Introduction by Phillip Krejcarek, Delmer Publishers
5. Multimedia – An Introduction by John Villamil, PHI
6. <https://www.adobe.com/in/creativecloud/photography/discover/dslr-camera.html>
7. Web sources suggested by the teacher concerned and the college librarian including reading material.



SEMESTER-V

COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY

Practical Credits: 1 2 hrs/week

COURSE OBJECTIVE:

The objective of the practical course on Optical Imaging and Photography is to provide students with hands-on experience and practical skills in capturing, processing, and interpreting optical images using various imaging techniques and equipment. The course aims to develop students' proficiency in operating optical imaging devices, utilizing image processing software, and analyzing images for different applications.

LEARNING OUTCOMES:

On successful completion of this practical course, student shall be able to:

1. List out, identify and understand various image formation techniques including Eye.
2. Learn the procedures of using Analog and Digital cameras.
3. Demonstrate the focusing techniques of Analog and Digital cameras.
4. Acquire skills in the editing and development of photos and videos.
5. Perform some experimental skills related to images, videos using the equipment available in the lab or in a local studio.

Practical (Laboratory) Syllabus:

6. Construction of a simple pin hole Camera and study it's working.
7. Capture an image using a Digital Camera and apply editing techniques.
8. Understanding various image formats and convert one image format into other(For ex: JPEG to BMP)
9. Convert a video stream into image stream by using a suitable editing software.
10. Evaluate the number of pixels and size of digital Image.
11. Comparison of the quality of a 8-bit, 16-bit and 32 bit images.
12. Perform the reduction and enlargement of a given Digital Image.
13. Change the appearance of an image by applying the filters (For ex: from the IR image of the given digital Image by suitable IR filter)

V. Lab References:

1. DSLR Photography for Beginners by Brian Black
2. The Art of Photography by Bruce Barnbaum
3. Photoshop for Photographers by John Slavio
4. <https://www.youtube.com/channel/UCwWyFRy2l6aUFMsRemP51Sw>. You Tube resource.
5. <https://www.udemy.com/course/complete-photography-course/>
6. Web sources suggested by the teacher concerned.



SEMESTER-V
COURSE 14B: OPTICAL IMAGING AND PHOTOGRAPHY
STUDENT ACTIVITIES

Co-Curricular Activities

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field: 05):*

- 1. For Teacher:** Training of students by the teacher (if necessary, by a local expert) in laboratory/field for not less than 15 hours on the field techniques/skills of Image formation by using lenses and mirrors. Also to make students to understand the construction, operation and the Physics principles involved in a normal Camera and Digital Camera.
- 2. For Student:** Students shall (individually) visit a local Photo studio or any such facility in a university/research organization/private and observe (i) the operation of different digital cameras, compact and SLR and in taking photographs using different types of lenses by varying aperture, shutter speed for still camera, video camera, CCTV and spy camera **or** (ii) The use of natural light, tungsten light, fluorescent light, electronic flash reflectors, exposure meters, studio flash and its accessories **or** (iii) the usage of various lighting techniques for different lenses and will do practice on special areas of photography in outdoor and indoor conditions **or** (iv) the different processes viz., Audio video recording, mixing, editing, dubbing of sound, using different types of microphones **or** (v) the handling of the digital video cameras, DVD, HDD, accessories and exposure to take different common shots, dimension of images and movements as per requirement **or** (v) the computer system by digital editing software, printing the photographs taken by digital cameras and the image transportation to the storage media, sending photographs through E-mail and Scanning the photographs, capture frames and analysis of images and record their observations and submit a hand-written Fieldwork/Project work not exceeding 10 pages in the given format to the teacher.
3. Max marks for Fieldwork/Project work: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
5. Tests (IE).

(b) Suggested Co-Curricular Activities:

1. Training of students by a related skilled person from a Photo studio.
2. Assignments (including technical assignments like identifying the tools & techniques involved in photography and handling, operational techniques of different Cameras with safety and security)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques related to Image formation and Photographic Techniques.
5. Practice taking outdoor photographs with a digital camera in (i) Black & White and (ii) Colour in the following conditions:
Landscapes – Street / Building – Sculpture – Insect / Animal movement – Industrial plant (outside view) – Children, birds (close up / long shot / model photography)- slow and fast moving objects-Night photography etc.
6. Shooting of different areas and topics such as sports, wildlife, modeling, drama, documentary, serial, story board making, news, interview, seminar/ workshop, industrial, live broadcasting, musical event, advertisement, etc.
7. Collection of material/figures/
8. photos related to various components of a Camera, writing and organizing them in a systematic way in a file.
9. Visits to any local Photo Studio or any Lab in universities, research organizations, private firms, etc.
10. Invited lectures and presentations on related topics by field/industrial experts.



SEMESTER-V

COURSE 15A: LOW TEMPERATURE PHYSICS & REFRIGERATION

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Low Temperature Physics & Refrigeration is to provide students with a comprehensive understanding of the fundamental principles, concepts, and applications of low-temperature physics and refrigeration systems. The course aims to develop students' theoretical knowledge and practical skills in working with low temperatures, understanding cryogenic phenomena, and operating refrigeration systems.

LEARNING OUTCOMES:

Students after successful completion of the course will be able to

1. Identify various methods and techniques used to produce low temperatures in the Laboratory.
2. Acquire a critical knowledge on refrigeration and air conditioning.
3. Demonstrate skills of Refrigerators through hands on experience and learns about refrigeration components and their accessories.
4. Understand the classification, properties of refrigerants and their effects on environment.
5. Comprehend the applications of Low Temperature Physics and refrigeration.

UNIT-I Production of Low Temperature

Production of low Temperatures-Introduction, Freezing mixtures, Joule-Thomson effect, Regenerative cooling, Different methods of liquefaction of gases, liquefaction of air, Production of liquid hydrogen and nitrogen, Adiabatic demagnetization, Properties of materials at low temperatures

UNIT-II Measurement of Low Temperature

Gas thermometer and its correction and calibration, Secondary thermometers, resistance thermometers, thermocouples, Vapor pressure thermometers, Magnetic thermometers, Advantages and drawbacks of each type of thermometer.

UNIT-III Principles of Refrigeration

Introduction to Refrigeration- Natural and artificial refrigeration, Stages of refrigeration, Types of refrigeration - Vapor compression and vapor absorption refrigeration systems, Refrigeration cycle and explanation with a block diagram, Introductory ideas on air- conditioning.

Refrigerants-Introduction, Ideal refrigerant, Properties of refrigerant, Classification of refrigerants, commonly used refrigerants, Eco-friendly refrigerants



UNIT-IV Components of Refrigerator

Refrigerator and its working, Block diagram, Coefficient of Performance (COP), Tons of refrigeration (TR) and Energy Efficiency Ratio (EER), Refrigerator components: Types of compressors, evaporators, condensers, and their functional aspects, defrosting in a refrigerator, Refrigerant leakage and detection

UNIT-V Applications of Low Temperature & Refrigeration

Applications of Low temperatures: Preservation of biological material, Food freezing, liquid nitrogen and liquid hydrogen in medical field, Superconducting magnets in MRI- Tissue ablation (cryosurgery) - Cryogenic rocket propulsion system.

Applications of refrigeration: Domestic refrigerators, Water coolers, Cold storages, Ice plants, Food preservation methods, Chemical and Process industries, Cold treatment of metals, Construction field, Desalination of water, Data centers.

References

1. Heat and Thermodynamics by Brij Lal & N. Subramanyam, S. Chand Publishers.
2. Thermal Physics by S C Garg, R M Bansal & C K Ghosh, McGrawHill Education, India
3. Heat and Thermodynamics by M M Zemansky, McGrawHill Education (India).
4. Low-Temperature Physics by Christian E. & Siegfried H., Springer.
5. Thermal Engineering by S. Singh, S. Pati, Ch: 18 Introduction to Refrigeration.
6. The Physics Hyper Text Book. Refrigerators. <https://physics.info/refrigerators/>
7. Refrigeration and Air Conditioning by Manohar Prasad, New age international (P) limited, New Delhi
8. A course in Refrigeration and Air Conditioning by S.C. Arora and S. Domkundwar, Dhanpatrai and sons, Delhi
9. [https://trc.nist.gov/cryogenics/Papers/Review/2017-Low Temperature Applications and Challenges.pdf](https://trc.nist.gov/cryogenics/Papers/Review/2017-Low%20Temperature%20Applications%20and%20Challenges.pdf)
10. <https://nptel.ac.in/content/storage2/courses/112105129/pdf/RAC%20Lecture%203.pdf>
11. Other Web sources suggested by the teacher concerned and the reading material.
<https://nptel.ac.in>



SEMESTER-V

COURSE 15A: LOW TEMPERATURE PHYSICS & REFRIGERATION

Practical	Credits: 1	2 hrs/week
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COURSE OBJECTIVE:

The objective of the practical course on Low Temperature Physics & Refrigeration is to provide students with hands-on experience and practical skills in working with low temperatures, operating refrigeration systems, and conducting experiments in the field of low temperature physics. The course aims to develop students' proficiency in handling cryogenic equipment, performing temperature measurements, and conducting experiments at low temperatures.

LEARNING OUTCOMES:

On completion of practical course, student shall be able to

1. List out, identify and handle equipment used in refrigeration and low temperature lab.
2. Learn the procedures of preparation of Freezing Mixtures.
3. Demonstrate skills on developing various Freezing mixtures and materials and their applications in agriculture, medicine and day to day life.
4. Acquire skills in observing and measuring various methodologies of very low temperatures
5. Perform some techniques related to Refrigeration and Freezing in daily life.

Practical (Laboratory) Syllabus: (30 hrs. Max marks: 50))

Record the Principles and applications of Refrigerators and Freezers.

1. Measure the temperatures below Melting point of Ice using a thermometer available in the Lab.
2. Make a freezing mixture by adding different salts viz., Sodium chloride, Potassium Hydrate (KOH), Calcium chloride to ice in different proportions and observe the temperature changes.
3. Study the operation of a refrigerator and understand the working of different parts.
4. Study the properties of refrigerants like chlorofluorocarbons-hydrochlorofluorocarbons and record the lowest temperatures obtained.
5. Consider a simple faulty refrigerator and try to troubleshoot the simple problems by understanding its working.
6. Understand the practical problem of filling the Freon Gas into the Refrigerator.
7. Get the Liquid Nitrogen or Liquid Helium from nearby Veterinary Hospital and measure their temperatures using chromel-alumel thermocouple or mercury thermometer and observe their physical properties like colour, smell etc and precautions to be taken for their safe handling.
8. Preparation of freeze drying food with Dry ice and liquid nitrogen
9. Preparation of freeze drying food with liquid nitrogen



STUDENT ACTIVITIES

Co-Curricular Activities:

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field: 05)*

1. **For Teacher:** Training of students by the teacher in the laboratory/field for a total of not less than 15 hours on the techniques/skills of Low Temperature Production, methods used and applications of Low temperatures and refrigeration in day to day life and other applications in medicine and industry.
2. **For Student:** Student shall (individually) visit (i) a small ice plant or a cold storage plant (ii) Air Conditioner (AC) repair shop or (iii) Refrigerator repair shop to understand the construction, working principle and the trouble shooting of these devices after interacting with the technicians. **Or** Student shall observe the various thermodynamic processes taking place while working with the refrigerator and observe the leak detection in refrigeration system by different methods, air removal and charging of a refrigeration unit and testing of a refrigeration system to find out the Refrigerating capacity/Ton of refrigeration (TR) and the Power input. **Or** Student shall identify the refrigerant cylinder by color coding and standing pressure. **Or** Student shall visit the freezer aisle of a supermarket and observes the bags of different frozen fruits. Student shall write the observations and submit a hand-written Fieldwork/Project work not exceeding 10 pages in the given format to the teacher.
3. Max marks for Fieldwork/Project work: 05.
4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*
5. Unit tests (IE).

(b) Suggested Co-Curricular Activities

1. Training of students by related Factory, industrial experts.
2. Assignments (including technical assignments like identifying tools in Refrigerators, Freezers and their handling, operational techniques with safety and security)
3. Seminars, Group discussions, Quiz, Debates etc. (on related topics).
4. Preparation of videos on tools and techniques in Low Temperatures and applications.
5. Collection of material/figures/photos related to substances used in Freezing Mixtures, their Properties and availability etc., writing and organizing them in a systematic way in a file.
6. Visits to Ice plants and labs in universities, research organizations, private firms, etc.
7. Making your own mini refrigerator at home
8. Build your own water cooler with the materials available at home.
9. Making hand launched liquid nitrogen rockets
10. Experiments with Liquid nitrogen and strawberry/ banana/ lemon/ onion/ mushroom/egg etc. (*To be tried under professional supervision only*).
11. Invited lectures and presentations on related topics by field/industrial experts
12. Identification of different Ozone-depleting substances (ODS) that damage the ozone layer in the upper atmosphere.
13. Demonstration to illustrate the greenhouse effect and the role of carbon dioxide as a greenhouse gas using plastic water bottles, flood light lamp, beakers and temperature sensors and observe the temperature changes.

<https://edu.rsc.org/experiments/modelling-the-greenhouse-effect/1543.article>

<https://sealevel.jpl.nasa.gov/files/archive/activities/ts1hiac1.pdf>



SEMESTER-V

COURSE 15B: SOLAR ENERGY AND ITS APPLICATIONS

Theory

Credits: 3

3 hrs/week

COURSE OBJECTIVE:

The objective of the course on Solar Energy and Its Applications is to provide students with a comprehensive understanding of solar energy technologies, their principles, and their applications. The course aims to develop students' knowledge and skills in harnessing solar energy for various purposes, including electricity generation, heating, and cooling.

LEARNING OUTCOMES:

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

- ❖ Understand Sun structure, forms of energy coming from the Sun and its measurement.
- ❖ Acquire a critical knowledge on the working of thermal and photovoltaic collectors.
- ❖ Demonstrate skills related to callus culture through hands on experience
- ❖ Understand testing procedures and fault analysis of thermal collectors and PV modules.
- ❖ Comprehend applications of thermal collectors and PV modules

Unit - I: Basic Concepts of Solar Energy

Spectral distribution of solar radiation, Solar constant, zenith angle and Air-Mass, standard time, local apparent time, equation of time, direct, diffuse and total radiations. Pyrheliometer - working principle, direct radiation measurement, Pyranometer-working Principle, diffuse radiation measurement, Distinction between the two meters.

Unit - II: Solar Thermal Collectors

Solar Thermal Collectors-Introduction, Types of Thermal collectors, Flat plate collector – liquid heating type, Energy balance equation and efficiency, Evacuated tube collector, collector overall heat loss coefficient, Definitions of collector efficiency factor, collector heat-removal factor and collector flow factor, Testing of flat-plate collector, solar water heating system, natural and forced circulation types. Concentrating collectors, Solar cookers, Solar dryers, Solar desalinators.

Unit - III: Fundamentals of Solar Cells

Semiconductor interface, Types, homo junction, hetero junction and Schottky barrier, advantages and drawbacks, Photovoltaic cell, equivalent circuit, output parameters, conversion efficiency, quantum efficiency, Measurement of I-V characteristics, series and shunt resistance, their effect on efficiency, Effect of light intensity, inclination and temperature on efficiency

Unit -IV: Types of Solar cells and Modules

Types of solar cells, Crystalline silicon solar cells, I-V characteristics, poly-Si cells, Amorphous silicon cells, Thin film solar cells-CdTe/CdS and CuInGaSe₂/CdS cell configurations, structures, advantages and limitations, Multi junction cells – Double and triple junction cells. Module fabrication steps, Modules in series and parallel, Bypass and blocking diodes



Unit – V: Solar Photovoltaic Systems

Energy storage in PV systems, Energy storage modes, electrochemical storage, Batteries, Primary and secondary, Solid-state battery, Molten solvent battery, lead acid battery and dry batteries, Mechanical storage – Flywheel, Electrical storage –Super capacitor

References:

1. Solar Energy Utilization by G. D. Rai, Khanna Publishers
2. Solar Energy- Fundamentals, design, modelling and applications by G.N. Tiwari, Narosa Publications, 2005.
3. Solar Energy-Principles of thermal energy collection & storage by S.P. Sukhatme, TataMcGraw Hill Publishers, 1999.
4. Science and Technology of Photovoltaics, P. Jayarama Reddy, CRC Press (Taylor & Francis Group), Leiden &BS Publications, Hyderabad, 2009.
5. Solar Photovoltaics- Fundamentals, technologies and applications, Chetan Singh Solanki, PHI Learning Pvt. Ltd.,
6. Web sources suggested by the teacher concerned and the college librarian including reading material.
 - (a) https://courses.edx.org/c4x/DelftX/ET.3034TU/asset/solar_energy_v1.1.pdf
 - (b) [https://www.sku.ac.ir/Datafiles/BookLibrary/45/John%20A.%20Duffie,%20William%20A.%20Beckman\(auth.\)-Solar%20Engineering%20of%20Thermal%20Processes,%20Fourth%20Edition%20\(2013\).pdf](https://www.sku.ac.ir/Datafiles/BookLibrary/45/John%20A.%20Duffie,%20William%20A.%20Beckman(auth.)-Solar%20Engineering%20of%20Thermal%20Processes,%20Fourth%20Edition%20(2013).pdf)



SEMESTER-V

COURSE 15B: SOLAR ENERGY AND ITS APPLICATIONS

Practical

Credits: 1

2 hrs/week

COURSE OBJECTIVE:

The objective of the practical course on Solar Energy and Its Applications is to provide students with hands-on experience and practical skills in working with solar energy systems, performing measurements and analysis, and implementing solar energy projects. The course aims to develop students' proficiency in solar energy system installation, maintenance, performance analysis, and practical application.

LEARNING OUTCOMES:

On successful completion of this practical course, students shall be able to:

1. List out and identify various components of solar thermal collectors and systems, solar photovoltaic modules and systems.
2. Learn the procedures for measurement of direct, global and diffuse solar radiation, I -V characteristics and efficiency analysis of solar cells and modules.
3. Demonstrate skills acquired in evaluating the performance of solar cell / module in connecting them appropriately to get required power output.
4. Acquire skills in identification and elimination of the damaged panels without affecting the output power in a module / array.
5. Perform procedures and techniques related to general maintenance of solar thermal and photovoltaic modules.

Practical (Laboratory) Syllabus:

1. Measurement of direct radiation using pyrheliometer.
2. Measurement of global and diffuse radiation using pyranometer.
3. Evaluation of performance of a flat plate collector
4. Evaluation of solar cell / module efficiency by studying the I – V measurements.
5. Determination of series and shunt resistance of a solar cell / module.
6. Determination of efficiency of two solar cells / modules connected in series.
7. Determination of efficiency of two solar cells / modules connected in parallel.
8. Study the effect of input intensity on the performance of solar cell / module.
9. Study the influence of cell / module temperature on the efficiency.
10. Study the effect of cell / module inclination on the efficiency.

Lab References:

1. Solar Photo voltaic- Alab training manual, C.S. Solanki et al., Foundation Books Publishers, 2012.
2. Laboratory Manual on Solar thermal experiments, HP Garg, TC Kandpal, Narosa Publishing House 2000.
3. Web sources suggested by the teacher concerned.

<https://renewablelab.niu.edu/experiments/solarPanel> Development of simple solar hot water collector:

<https://www.youtube.com/watch?v=WP8H5IOTwYU>

<https://www.instructables.com/Solar-Water-Heater-From-Scratch/>



Co-Curricular Activities

(a) Mandatory: (*Training of students by teacher in field related skills: (lab:10 + field: 05)*

1. For Teacher: Training of students by the teacher in the laboratory/field for not less than 15 hours on the field techniques/skills related to measurement of direct, diffused and global solar radiation; demonstration of procedures used in the performance evaluation of solar flat plate collectors, solar photovoltaic cells and modules measurement of different parameters in the calculation of efficiency.

2. For Student: Students shall visit to solar thermal and photovoltaic laboratories in universities/research organizations/ nearby industries to observe and understand the techniques and procedures used for evaluation of solar collector, solar cell and module efficiencies. They shall write their observations and submit to the teacher hand-written Fieldwork/Project work not exceeding 10 pages in the given format.

3. Max marks for Fieldwork/Project work: 05.

4. Suggested Format for Fieldwork/Project work: *Title page, student details, index page, details of place visited, observations, findings and acknowledgements.*

5. Unit tests (IE).

(b) Suggested Co-Curricular Activities

1. Training of students by related industrial/ technical experts using guest lectures/ invited talks.
2. Assignments (including technical assignments like identifying components of a solar hot water and solar photovoltaic systems and their handling, operational techniques and maintenance procedures with safety and security)
3. Seminars, Group discussions, Quiz, Debates etc. on related topics.
4. Preparation of videos on thermal and photovoltaic systems and technical procedures.
5. Collection of brochures/figures/photos related to products and applications of solar energy and organizing them in a systematic way in a file.
6. Making a (i) solar panel (ii) solar light (iii) solar cooker (iv) solar oven (v) solar inverter at Home.
7. Visits to nearby solar thermal system as well as solar photovoltaic power stations, firms, research organizations etc.
