

K.L.E. Society's

R. L. Science Institute (Autonomous), Belagavi

DEPARTMENT OF PHYSICS

B.Sc. (Basic/Honors) PHYSICS

DSC & OEC Syllabus (NEP)

of

Undergraduate Programme

B.Sc. III & IV Semester

w.e.f Academic year 2022-23

Syllabus of III Semester Physics

Program Outcomes:	
1.	Disciplinary knowledge
2.	Communication Skills
3.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
4.	Problem-solving
5.	Research-related skills
6.	Cooperation/ Teamwork/ Leadership readiness/Qualities
7.	Information/ Digital literacy/Modern Tool Usage
8.	Environment and Sustainability
9.	Multicultural competence
10.	Multi-Disciplinary
11.	Moral and ethical awareness/Reasoning
12.	Lifelong learning / Self-Directed Learning

Course Content Semester – III Wave Motion and Optics	
Course Title: Wave Motion and Optics	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: Physics Expert Committee	

Prerequisites
Fundamentals of waves

Course Learning Outcomes	
At the end of the course students will be able to:	
i.	Identify different types of waves by looking into their characteristics.
ii.	Formulate a wave equation and obtain the expression for different parameters associated with waves.
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions, such as, when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.
vii.	Give the different models of light propagation and phenomenon associated and measure the parameters like the wavelength of light using experiments like Michelson interferometer, interference and thin films.
viii.	Explain diffraction due to different objects like single slit, two slits, diffraction of grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.

Course Articulation Matrix													
Mapping of Course Outcomes (CO) Program Outcomes													
Course Outcomes/Program Outcomes		1	2	3	4	5	6	7	8	9	10	11	12
i.	Identify different types of waves by looking into their characteristics.	X	X	X	X	X	X					X	X
ii.	Formulate a wave equation and obtain the expression for different parameters associated with waves.	X	X	X	X	X	X					X	X

iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions such as when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.	X	X	X	X	X	X						X	X
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.	X	X	X	X	X	X						X	X
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.	X	X	X	X	X	X						X	X
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.	X	X	X	X	X	X						X	X
vii.	Give the different models of light propagation and phenomenon associated and measure the parameters like the wavelength of light using experiments like Michelson interferometer, interference and thin films.	X	X	X	X	X	X						X	X
viii.	Explain diffraction due to different objects like single slit, two slits, diffraction grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.	X	X	X	X	X	X						X	X
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.	X	X	X	X	X	X						X	X

Wave Motion and Optics				
Unit – 1 -Waves and Superposition of Harmonic Waves				
The Portion to be Covered				
<p>Waves: Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation, Wave Equation – Differential form (derivation). Particle and Wave Velocities: Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton’s Formula for Velocity of Sound. Laplace’s Correction (Derivation). (6 Hours)</p> <p>Superposition of Harmonic Waves : Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies .Concept of Beats and its analytical treatment. Superposition of two perpendicular Harmonic Oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous’ figures. Problems (7 Hours)</p>				
Topic Learning Outcomes				
At the end of the topic, students should be able to:				
SL No	TLO’s	BL	CO	PO
i.	Explain the difference between plane and spherical waves, longitudinal and transverse waves and give their characteristics.	L2	1	1-6, 11-12
ii.	Write down an equation for the progressive wave in its differential form.	L2	1	1-6, 11-12
iii.	Obtain the relation between particle and wave velocity.	L2	1	1-6, 11-12
iv.	Obtain an expression for intensity of progressive waves.	L2	1	1-6, 11-12
v.	Obtain Newton's formula for the velocity of sound and discuss the factors for which sound velocity is dependent.	L2	2	1-6, 11-12
vi.	Apply the Laplace’s correction to the equation of motion of a progressive wave.	L2	2	1-6, 11-12
vii.	With examples explain ripple and gravity waves.	L1	2	1-6, 11-12
viii.	Give the theory of superposition of two linear waves having equal frequencies and different frequencies.	L2	3	1-6, 11-12
ix.	Discuss the formation of different Lissajous figures under different conditions of amplitude and frequency when they superimpose perpendicularly.	L2	3	1-6, 11-12
x.	Give some applications of an Lissajous figures.	L1	3	1-6, 11-12
xi.	Higher order problems.	L3	1,2,3	1-6, 11-12

Teaching and Learning Methodology	
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/Collaborative Learning/ Experiential Learning / Self-Directed Learning etc	
Assessment Techniques	
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc	
Suggested Activities	
Activity No. 1	We know that sound is produced because of vibration. Look into at least 10 musical instruments and identify the regions of vibrations that produces the sound and those parts which enhances the sound because of reverberation. <ol style="list-style-type: none"> 1. Identify one common element in all of these. 2. Identify equipment's which creates beats and try to explain the underlying basic principles. Demonstrate the examples of beats using two tuning forks. 3. Identify what will happen when you drop a stone in a standing water, and when your drop two stones side by side. 4. Make your observations sketch them and comment on it in a report.
Activity No. 2	Draw two sine waves (Amplitude vs time) one shifted with other in phase. Identity where the resonation occurs for each phase shift. Plot phase vs time taken forresonance.
Activity No. 3	Take smooth sand, place a pointed edged pen vertically on the sand. To the mid of the pen, connect two perpendicular threads. Pull these perpendicular threads by varying the forces and timings. Note down the different shapes produced on the sand. Try to interpret the shapes. Make a report of it
Activity No. 4	Hang a pot with sand, which has a hole in the bottom. Gently pull the pot on one side and observe the pattern formed by the sand on the floor. Report the observations.
Activity No. 5	Design a coupled pendulum. Study the impact of the motion of one pendulum over the other pendulum by varying the length, direction of the motion of one pendulum and mass of pendulum and observe the resultant changes. Trace the path of the bobs and make a report.

Activity No. 6	<p>Note for the teachers for the activity: Make 3 groups among students and assign each group the activity of drawing one of the 3 graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. All group will measure the total damping time of oscillating spring. (Using mobile or scale) And plot a graph of the-</p> <ol style="list-style-type: none"> 1. Varying load on the spring and amplitude at the centre. 2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. 3. Vary the load in the centre of the spring and measure the amplitude at the centre.
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Wave Motion and Optics

Unit – 2 - Standing Waves and Acoustics

The Portion to be Covered

Standing Waves : Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string Free vibrations, Damped vibrations, Equation for damped vibrations. Forced vibration, solution in exponential form, Concept of Resonance, Theory of Helmholtz resonator.

Problems (7 Hours)

Acoustics:

Concept of sound, properties of sound, Musical sound and noises, Characteristic of musical sound, Distinguishing between music and noise, Intensity and loudness of sound-decibels. Intensity level-musical note and scale.

Acoustics of building: Reverberation and time of reverberation- absorption coefficient. Derivation of Sabine's formula. Measurement of reverberation time. Acoustic aspects of hall and auditorium. **Problems (6 Hours)**

Topic Learning Outcomes				
At the end of the topic, students should be able to:				
SL No	TLO's	BL	CO	PO
i.	Discuss the Transverse waves produced in stretched string and obtain the expression for the same.	L2	3	1-6, 11-12
ii.	Give a qualitative treatment of vibration of a string when it's both ends are fixed and free.	L2	3	1-6, 11-12
iii.	Explain normal modes of a stretched string .Obtain an expression for the energy density and discuss how this energy is transported along a stretched string.	L2	3	1-6, 11-12
iv.	Quantitatively bring about the mode of vibrations created in a rod.	L2	4	1-6, 11-12
v.	Explain types of waves that are produced in gas .Obtain an expression for the same.	L2	4	1-6, 11-12
vi.	With an analytical treatment explain the concept of resonance using the normal modes of vibrations of open and closed pipes.	L2	5	1-6, 11-12
vii.	Give the theory of Helmholtz resonator and explain how it is used to calculate some parameters of the way the standing waves are set in there.	L2	5	1-6, 11-12
viii.	Define Reverberation, Reverberation time and absorption coefficient of a material.	L1	5	1-6, 11-12
ix.	Obtain Sabine's Reverberation formula and discuss what are the factors on which the Reverberation time depends on.	L2	5	1-6, 11-12
x.	List out which are different parameters within a building which effects the acoustics.	L1	6	1-6, 11-12
xi.	Explain what are good acoustics of a building and how acoustics is measured in terms of intensity and pressure inside a building.	L2	6	1-6, 11-12
xii.	Higher order problems.	L3	4,5,6	1-6, 11-12

Teaching and Learning Methodology	
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.	
Formative Assessment Techniques	
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc	
Suggested Activities	
Activity No. 7	List different phenomenon where standing waves are found in nature. Identify the phenomena and reason for standing waves. Also identify the standing waves in musical instruments. Make a report of it.
Activity No. 8	<ol style="list-style-type: none"> 1. Go to 5 different newly constructed houses when they are not occupied and when they are occupied. Make your observations on sound profile on each room. Give the reasons. Make a report of it. 2. Visit three very good auditoriums, list out different ways in which the acoustic arrangements have been done (as decoration and Civil works). Look for the reasons in Google and identify which is acoustically the best auditorium among the three you visited. Make a report of it.
Activity No. 9	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO₄) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop a marble on the liquid at the centre of the bowl. Repeat the experiment by dropping the marble from the different heights. Plot a graph of-</p> <ol style="list-style-type: none"> 1. Height v/s time of oscillation 2. Weight of the marble v/s time of oscillation

Activity No. 10	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take two marbles of same weight. Drop both the marbles on the surface of the liquid from some height. With the help of the mobile take the picture and measure the position of interface of two wave fronts formed in the liquid. Plot graphs for different activities by doing the following activities.</p> <ol style="list-style-type: none"> 1. By dropping two marbles of same weight from different heights. 2. By dropping two marbles of different weight from the same height
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Wave Motion and Optics

Unit – 3 - Nature of light and Interference

The Portion to be Covered

Nature of light : Theories of light :- Newton’s Corpuscular, Wave theory, Electromagnetic theory and Quantum theory of light. **(3 Hours)**

Interference of light by division of wave front: Huygens’s Theory-Concept of wave-front-Interference pattern produced on the surface of water-Coherence-Interference of light waves by division of wave-front- Young’s double slit experiment- derivation of expression for fringe width-Fresnel Biprism- Interference with white light .Problems**(5 Hours)**

Interference of light by division of amplitude: Interference by division of amplitude-Interference by a plane parallel film illuminated by a plane wave-Interference by a film with two non-parallel reflecting surfaces- colour of thin films—Newton’s rings due to reflected light and transmitted light -Michelson Interferometer-Determination of wavelength of light. Problems **(5 Hours)**

Topic Learning Outcomes				
At the end of the topic, students should be able to:				
SL No	TLO's	BL	CO	PO
i.	Explain using Michelson interferometer how to determine the wavelength of light.	L2	7	1-6, 11-12
ii.	Give an account of the different possible shapes that are obtained in Michelson interferometer experiment and their relevance.	L2	7	1-6, 11-12
iii.	Discuss the wave model and the Corpuscular model of light.	L2	7	1-6, 11-12
iv.	Explain Maxwells electromagnetic waves.	L2	7	1-6, 11-12
v.	Give an account of the phenomenon of wave-particle duality.	L1	7	1-6, 11-12
vi.	Give the Huygens theory of wave-front.	L1	7	1-6, 11-12
vii.	Define Interference. Give some examples of Interference.	L1	7	1-6, 11-12
viii.	Give the theory of interference due to two coherent sources of light and obtain an expression for the wavelength of monochromatic source of light (Young's double slit experiment)	L2	7	1-6, 11-12
ix.	Explain how using personal biprism ,a monochromatic coherent source of light is obtained. Using this experimental setup explain how the wavelength of monochromatic sources of light is determined.	L2	7	1-6, 11-12
x.	Give the theory of interference due to division of amplitude by parallel and non-parallel plates.	L1	7	1-6, 11-12
xi.	Explain how Newton's rings are obtained and discuss how the wavelength of light is determined using this experiment.	L2	7	1-6, 11-12
xii.	Higher order problems.	L3	7	1-6, 11-12
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.				
Formative Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				

Suggested Activities

Activity No. 11	In the table given below explore which phenomenon can be explained by what and make a report of it.				
	Sl No	Phenomenon	Particle of Light	Wave Nature	Dual Nature
	1.	Pinhole camera			
	2.	Formation of images on lenses			
	3.	Formation of images on mirror			
	4.	Interference			
	5.	Polarization			
	6.	Diffraction due to single slit			
	7.	Black body radiation			
	8.	Photoelectric effect			
	9.	De-Broglie hypothesis			
10.	Devison&Germer Experiment				
Activity No. 12	Why colour strips are seen in paddles on roads in rainy seasons try to simulate the same. Give the reasons. Make a report of it.				
Activity No. 13	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> The first slide will explain the process of doing the experiment. In the second slide. Students will show the graph of measurement. In the third slide, they will list three observations from that study. <p>Activity: Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO₄) solution. Place a small non-oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Plot graph for the different observations.</p> <p>For teachers: Demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Ask the students to comment on the observations.</p>				

Wave Motion and Optics

Unit – 4 - Diffraction and Polarisation

The Portion to be Covered

Fresnel Diffraction- Fresnel's Diffraction. Half Period Zone using rectilinear propagation of light. Zone plate: Construction, theory and working. Comparison between zone plate and convex lens .Problems.(3 Hours)

Fraunhofer diffraction : Fraunhofer's diffraction at single slit. Diffraction grating. Theory of plane transmission grating. Resolving power. Rayleigh's criteria. Resolving power of prism. Resolving power of telescope. Resolving power of grating (qualitative).Problems (5 Hours)

Polarisation:

Transverse nature of light waves- plane of vibration and plane of polarisation. Malu's law. Double refraction. Positive and negative plates. Retardation plates: Quarter wave plate and half wave plate. Polaroids and its types, Production of Circular and elliptical polarization, Optical Activity: Fresnel's Theory of optical activity. Specific rotation, Determination of specific rotation of sugar solution using polarimeter. Problems(5 Hours)

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	B L	CO	PO
i.	Define Fraunhofer diffraction.	L2	8	1-6, 11-12
ii.	Give a qualitative treatment of single slit/diffraction double slit diffraction.	L2	8	1-6, 11-12
iii.	Explain the theory of diffraction due to grating and the normal and oblique incidence.	L2	8	1-6, 11-12
iv.	Explain how the resolving power of a grating depends of the number of slits used.	L2	8	1-6, 11-12
v.	Give the theory of Fresnel half period zones.	L2	8	1-6, 11-12
vi.	Discuss zone plates with respect to convex lenses.	L2	8	1-6, 11-12
vii.	Explain optical polarization and polaroid.	L2	9	1-6, 11-12
viii.	Give different types of polaroid.	L2	9	1-6, 11-12
ix.	Give the theory of phenomenon of double refraction and explain what are ordinary and extraordinary rays.	L2	9	1-6, 11-12
x.	Give the theory of quarter wave plates and half wave plates.	L2	9	1-6, 11-12
xi.	Explain optical activity with theory. Give an experimental method to measure the optical activity of a material.	L2	9	1-6, 11-12

xii.	Higher order problems.	L3	8,9	1-6, 11-12
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.				
Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				
Suggested Activities				
Activity No. 14	<p>Explain polarization of light through a chart. List out the surfaces that reflect polarized light. Learn how polarization of light can be done by both transmission and reflection. Perform an experiment and make a report. USING CDs AND DVDs AS DIFFRACTION Gratings Ref:https://www.mnin.org/sites/default/files/files/Karen_Rama_USING_CDs_AND_DVDs_AS_DIFFRACTION GRATINGS_0.pdf Obtain the diffraction spectra using a CD and design an experiment to find the distance between the tracks on it)</p> <p>(Ref: https://www.brighthubeducation.com/science-lessons-grades-9-12/39347-diffraction-experiment-measuring-groove-spacing-on-cds/, https://silo.tips/download/diffraction-from-a-compact-disk)</p>			
Activity No. 15	<p>What is the physics behind making 3D movies? Group Discussion (https://www.slideserve.com/rae/physics-behind-3d-movies-powerpoint-ppt-presentation) Make a report of it.</p>			
Activity No. 16	<p>List out different types of zone plates and look for their applications in day to day life. Make a report of it.</p>			
Activity No. 17	<p>Collect information and study how optically polarizing lenses are made. Visit a nearby lens making facility. Learn the principle behind sunglasses. Make a report of it.</p>			

Activity No. 18	<p>Note for the teachers for the activity: Make 3 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Identify any 3 sharp edges of varying thickness and assign them to 3 groups. Shine a laser light pointing towards the edge of the needle. Observe the patterns formed on the wall or screen and measure the distance between the bands. Correlate the distance between the bands formed with the thickness of the edge and the distance from the edge to the screen. By this, calculate the wavelength of the laser light used.</p>
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Textbooks

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	The Physics of Waves and Oscillations,	N K Bajaj	Tata McGraw-Hill Publishing Company Ltd., Second Edition,	1984
2	Waves and Oscillations	N Subramanyam and Brij Lal	Vikas Publishing House Pvt. Ltd., Second Revised Edition	2010
3	A Text Book of Sound	D R Khanna and R S Bedi	Atma Ram & Sons, Third Edition	1952
4	Oscillations and Waves	Satya Prakash	PragathiPrakashan, Meerut, Second Edition	2003
5	Optics	AjoyGhatak	McGraw Hill Education (India) Pvt Ltd	2017
6	A text Book of Optics	Brij Lal, M N Avadhanulu& N Subrahmanyam	S. Chand Publishing	2012

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Berkeley Physics Course – Waves,	Frank S Crawford Jr.	Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition,.	2011
2	Optics	Eugene <i>Hecht</i>	Pearson Paperback	2019
3	Introduction To Optics	Pedrotti and Frank L ,	Pearson India	3rd Edition
4	Fundamentals of Optics	Francis Jenkins Harvey White	McGraw Hill Education	2017

Formative Assessment	
Assessment	Marks
Internal Assessment	20
REU based Group Activity (Conduct, Report, Presentation)	20
Total	40

Course outcomes:

- Improves the skill of handling optical equipments.
- Learns the calibration of Spectrometer

List of Experiments to be performed in the Laboratory	
Note: Minimum Eight experiments has to be performed	
1.	Velocity of sound through a wire using Sonometer.
2.	Frequency of AC using Sonometer.
3.	Study of Lissajous' Figures
4.	To verify the laws of transverse vibration using Melde's apparatus.
5.	Helmholtz resonator using tuning fork.
6.	Helmholtz resonator using electrical signal generator.
7.	To determine refractive index of the Material of a prism using sodium source.
8.	To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
9.	To determine the wavelength of sodium source using Michelson's interferometer.
10.	To determine wavelength of sodium light using Fresnel Biprism.
11.	To determine wavelength of sodium light using Newton's Rings
12.	To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
13.	To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
14.	To determine dispersive power and resolving power of a plane diffraction grating.
15.	Verification of laws of vibrations using stretched string.
16.	Verification of Malus Law
17.	Determination of wavelength of He-Ne laser light using single slit experiment

18	Determination of resolving power of telescope
19	Double refracting Prism.

Reference Book for Laboratory Experiments				
Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Advanced Practical Physics for students	B.L. Flint and H.T. Worsnop	Asia Publishing House.	1971
2	A Text Book of Practical Physics	I. Prakash & Ramakrishna	Kitab Mahal, 11 th Edition	2011
3	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers, 4 th Edition	1985
4	A Laboratory Manual of Physics for undergraduate classes	D.P.Khandelwal	Vani Publications.	1985

OPEN ELECTIVE SUBJECT

Year	2	Course Code: 21BSC3O3PHY3	Credits	03
Sem.	3		Course Title: CLIMATE SCIENCE	Hours
Formative Assessment Marks: 40		Summative Assessment Marks: 60		Duration of ESA:.02 hrs.
Course outcomes				
<ul style="list-style-type: none"> • Enables the students to understand the reasons for climate change and green house effect. • Understands the principles of general circulation model. • Get exposed to the climate science research centers in India and abroad. • Acquire the knowledge about clouds seeding and cyclones. 				
Unit. No	Course Content			
Unit I	<p>Atmosphere: Atmospheric Science (Meteorology) as a multidisciplinary science. Physical and dynamic meteorology, Some terminology, difference between weather and climate, weather and climate variables, composition of the present atmosphere: fixed and variable gases, volume mixing ratio (VMR), sources and Sinks of gases in the atmosphere. (10 hours)</p>			
Unit II	<p>Green house gases. Structure (layers) of the atmosphere. Temperature variation in the atmosphere, temperature lapse rate, mass, pressure and density variation in the atmosphere. Distribution of winds.</p> <p>Climate Science: Overview of meteorological observations, measurement of: temperature, humidity, wind speed and direction and pressure. Surface weather stations, upper air observational network, satellite observation. Overview of clouds and precipitation, aerosol size and concentration, nucleation, droplet growth and condensation (qualitative description). (10 hours)</p>			
Unit III	<p>Cloud seeding, lightning and discharge. Formation of trade winds, cyclones.</p> <p>Modelling of the atmosphere: General principles, Overview of General Circulation Models (GCM) for weatherforecasting and prediction. Limitations of the models.</p> <p>R and D institutions in India and abroad dedicated to climate Science, NARL, IITM, CSIR Centre for Mathematical Modeling and Computer Simulation, and many more. (10 hours)</p>			

Unit IV	<p>Global Climate Change</p> <p>Green house effect and global warming, Enhancement in concentration of carbon dioxide and other green house gases in the atmosphere, Conventional and non-conventional energy sources and their usage. EL Nino/LA Nino Southern oscillations.</p> <p>Causes for global warming: Deforestation, fossil fuel burning, industrialization.</p> <p>Manifestations of global warming: Sea level rise, melting of glaciers, variation in monsoon patterns, increase in frequency and intensity of cyclones, hurricanes, tornadoes. (10 hours)</p>
	<p>Activities to be carried out on Climate Science:</p> <ol style="list-style-type: none"> 1. Try to find answer to the following questions: <ol style="list-style-type: none"> (a) Imagine you are going in a aircraft at an altitude greater than 100 km. The air temperature at that altitude will be greater than 200°C. If you put your hands out of the window of the aircraft, you will not feel hot. (b) What would have happened if ozone is not present in the stratosphere. 2. Visit a nearby weather Station and learn about their activities. 3. Design your own rain gauge for rainfall measurement at your place. 4. Learn to determine atmospheric humidity using wet bulb and dry bulb thermometers. 5. Visit the website of Indian Institute of Tropical Meteorology (IITM), and keep track of occurrence and land fall of cyclone prediction. 6. Learn about ozone layer and its depletion and ozone hole. 7. Keep track of melting of glaciers in the Arctic and Atlantic region through data base available over several decades. 8. Watch documentary films on global warming and related issues (produced by amateur film makers and promoted by British Council and BBC).
<p>References:</p> <ol style="list-style-type: none"> 1. Basics of Atmospheric Science – A Chndrashekar, PHI Learning Private Ltd. New Delhi, 2010. 2. Fundamentals of Atmospheric Modelling- Mark Z Jacobson, Cambridge University Press, 2000. 	

Syllabus of IV Semester Physics

Program Outcomes:	
13.	Disciplinary knowledge
14.	Communication Skills
15.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
16.	Problem-solving
17.	Research-related skills
18.	Cooperation/ Teamwork/ Leadership readiness/Qualities
19.	Information/ Digital literacy/Modern Tool Usage
20.	Environment and Sustainability
21.	Multicultural competence
22.	Multi-Disciplinary
23.	Moral and ethical awareness/Reasoning
24.	Lifelong learning / Self-Directed Learning

Course Content Semester – IV Thermal Physics and Electronics	
Course Title: Thermal Physics and Electronics	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: Physics Expert Committee	

Prerequisites
Study of Pre-University

Course Learning Outcomes**At the end of the course students will be able to:**

vii.	Apply the laws of thermodynamics and analyze the thermal system.
viii.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.
ix.	Use the concepts of semiconductors to describe different Semiconductor devices such as diode transistors, BJT, FET etc and explain their functioning.
x.	Explain the functioning of OP-AMPS and use them as the building blocks of logic gates.
xi.	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.

Course Articulation Matrix**Mapping of Course Outcomes (CO) Program Outcomes**

Course Outcomes/Program Outcomes		1	2	3	4	5	6	7	8	9	10	11	12
i	Apply the laws of thermodynamics and analyze the thermal system.	X	X	X	X	X	X					X	X
ii	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.	X	X	X	X	X	X					X	X
iii	Use the concepts of semiconductors to describe different Semiconductor devices like diode transistors, BJT, FET etc and explain their functioning.	X	X	X	X	X	X					X	X
iv	Explain the functioning of OP-AMPS and them as the building blocks of logic gates.	X	X	X	X	X	X					X	X
v	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.	X	X	X	X	X	X					X	X

Thermal Physics and Electronics				
Unit – 1				
The Portion to be Covered				
Laws of Thermodynamics:				
Review of the concepts of Heat and Temperature.				
First, Second & Third Law of Thermodynamics(Qualitative) (03 Hours)				
Thermoelectricity: Seebeck effect and its explanation. Variation of thermo emf with temperature, neutral temperature and temperature of inversion. Thermoelectric series. Laws of thermo electric effects. Peltier's effect- Explanation, Peltier's coefficients and thermodynamics of Peltier's effect. Thomson effect – Explanation, Thomson coefficients. Derivation of the relation $\pi = TdE/dT$ and $\sigma_a - \sigma_b = Td^2E/dT^2$ Thermoelectric (Tait) diagrams				
Problems (08 Hours)				
Topic Learning Outcomes				
At the end of the topic, students should be able to:				
SL No	TLO's	BL	CO	PO
i.	Explain the first law of thermodynamics.	L1	1	1-6,11-12
ii.	Give the differential form of the first law of thermodynamics and define what is the internal energy.	L2	1	1-6,11-12
iii.	Obtain an expression for work done in isothermal and adiabatic processes.	L2	1	1-6,11-12
iv.	Give two systems of units of temperature measurement and give their equivalence.	L2	1	1-6,11-12
v.	Describe and Discuss heat engine based on Carnot cycle.	L2	1	1-6,11-12
vi.	Explain how the efficiency of refrigeration is measured?	L2	1	1-6,11-12
vii.	Detail out the application of the Carnot engine to a locomotion system.	L1	1	1-6,11-12
viii.	Define entropy and write an expression for entropy using the second law of thermodynamics.	L2	1	1-6,11-12
ix.	State the third law of thermodynamics and give its significance using the third law of thermodynamics describing why absolute zero temperature is not Unattainable.	L2	1	1-6,11-12
x.	High Order Problems.	L3	1	1-6,11-12

Teaching and Learning Methodology	
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.	
Assessment Techniques	
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc	
Suggested Activities	
Activity No. 1	<p>I feel cold because coldness enters my body. Discuss the statement in day-to- day life. Approximately give examples of</p> <ol style="list-style-type: none"> open system closed system and isolated system <p>Discuss when the temperature of the body is locked until what time you hold the thermometer in contact with a body. Discuss it in contact with laws of thermodynamics.</p> <p>Discuss why when a person works or does exercise, he sweats. Reason it with the laws of thermodynamics.</p>
Activity No. 2	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> The first slide will explain the process of doing the experiment. In the second slide. Students will show the graph of measurement. In the third slide, they will list three observations from that study. <p>Activity: Take four different sizes of same metal, preferable of same shape and give one piece to each group. Heat it uniformly on a hot plate. Keep a beaker of water with a thermometer immersed in it. Drop one hot metal into the water and record the temperature with time. Repeat the experiment for the other heated metal pieces of different sizes.</p> <ol style="list-style-type: none"> Plot a graph for the volume of the metal piece used v/s respective temperature change observed. Determine the heat capacity and specific heat of the metal used. <p>All groups shall also do the following activity:</p>

Activity No. 3	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations.</p>
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Thermal Physics and Electronics

Unit – 2

The Portion to be Covered

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Properties and Applications.

(2 Hours)

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Thermodynamic Relations (1) First order Phase Transitions with examples, Clausius - Clapeyron Equation (2) Values of $C_p - C_v$ (3) Joule-Thomson Effect and Joule-Thomson coefficient and derive an equation for Vander Walls gas. Attainment of low temperature by liquefaction of gases and adiabatic demagnetization. Problems

(4 Hours)

Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas: Mean, RMS and Most Probable Speeds. Degrees of Freedom, Law of Equipartition of Energy. Specific heats of Gases. Problems

(4 Hours)

Radiation: Blackbody radiation, spectral distribution, the concept of energy density and pressure of radiation, Wien's law, Wien's displacement law, Stefan-Boltzmann law, Rayleigh-Jeans law and Planck's law of radiation. Problems

(3 Hours)

Topic Learning Outcomes				
At the end of the topic, students should be able to:				
SL No	TLO's	BL	CO	PO
i.	State Maxwell relations.	L1	2	1-6, 11-12
ii.	Give examples where Maxwells relations are used.	L1	2	1-6, 11-12
iii.	Explain the phase transition. Which is called as first orderphase transition? Give Examples	L2	2	1-6, 11-12
iv.	State Clausius - Clapeyron Equation.	L1	2	1-6, 11-12
v.	Obtain an equation for difference in $C_P - C_V$.	L2	2	1-6, 11-12
vi.	State Joule-Thomson effect and Joule-Thomson coefficient.	L1	2	1-6, 11-12
vii.	Obtain an expression, giving the relation between pressure, volume and temperature for a real gas (Vander Waals gas).	L2	2	1-6, 11-12
viii.	Explain adiabatic demagnetization and how it is used to obtain low temperature by the liquidation of gases?	L2	2	1-6, 11-12
ix.	State Maxwell-Boltzmann Law of Distribution of Velocities inIdeal gases.	L1	2	1-6, 11-12
x.	Explain the mean RMS and most probable speeds in idealgases.	L1	2	1-6, 11-12
xi.	Explain degrees of freedom associated with particles in anideal gas?	L2	2	1-6, 11-12
xii.	Define the specific heat of a gas.	L1	2	1-6, 11-12
xiii.	Explain black body radiation and its spectral distribution.	L1	2	1-6, 11-12
xiv.	Explain the different laws used to describe different parts ofthe curves of a spectral distribution of black body radiation.	L2	2	1-6, 11-12
xv.	Define ultraviolet radiation catastrophe? Discuss	L2	2	1-6, 11-12
xvi.	Define Planck's law of radiation and discuss how it could describe the whole black body radiation curve.	L2	2	1-6, 11-12
xvii.	High Order Problems.	L3	2	1-6, 11-12

Teaching and Learning Methodology	
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.	
Assessment Techniques	
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc	
Suggested Activities	
Activity No. 4	<p>1. Measuring the Solar Constant Materials: Simple flat sided Jar and Thermometer. Activity: Bottle containing water is exposed to solar radiation. The rise in temperature and time taken are noted. Calculate the heat absorbed by water and relate it to the output of the Sun.</p> <p>2. Thermo emf Materials: Suitable two dissimilar metal wires, voltage measuring device. Activity: In this experiment student will assemble the thermocouple and study the three effects namely, Seebeck, Peltier, and Thompson.</p> <p>3. Inverse square law of radiation Materials: A cardboard with a grid, cardboard with a hole, supporting clips, a ruler, candle.</p> <p>4. Activity: Students set the device. They count the lighted squares on the cardboard with the grid by varying the distance. And make necessary measurements and calculations to arrive at the inverse square law of radiation.</p> <p>Ref: Activity Based Physics Thinking Problems in Thermodynamics: Kinetic Theory http://www.physics.umd.edu/perg/abp/think/thermo/kt.htm</p>

Activity No. 5	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take two dissimilar metal wires. Spot weld them forming two junctions. Dip one junction in ice and heat the other junction with a burner. Plot a graph of time of heating v/s Thermo EFM generated in the voltmeter.</p>
Activity No. 6	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Make 4 groups and give different-sized balloons to each group. Fit different-sized nozzles into the mouth of the large balloons. Measure the temperature or the EMF generated using a thermocouple placed at the mouth of the nozzle as the pressurised gas is released. Plot a graph of time v/s temperature. Vary the volume of the balloon and repeat the experiment. Plot the graph of volume v/s temperature difference created.</p>

Thermal Physics and Electronics

Unit – 3

The Portion to be Covered

Semiconductor devices: Semiconductor and its types, doping, Intrinsic and Extrinsic semiconductors, semiconductor diode (p-n junction) and its V-I Characteristics (Forward & Reverse).

Rectifier: Rectifications, Half-wave rectifier, Full-wave rectifier-i) Full wave centre tap ii) Full wave Bridge(Qualitative). Comparison between them.

Filters: Capacitor filter, Inductor filter, LC filter, Π - section filter (study of waveforms-qualitative), Comparison between them.

Zener diode: V-I Characteristics, Explanation of Zener Breakdown mechanism(Avalanche & Zener). Voltage regulator -Zener diode used as voltage regulator using unregulated DC voltage bridge rectifier. Problems (6 hours)

Junction Transistors: Basics of Bipolar Junction (BJT), types of transistors, construction and operation transistors, Transistor configuration , Common Base, Common Emitter and Common Collector Characteristics, h-parameters of a transistor and their determination using CE configuration, Transistor as an Amplifier (CE) with frequency response .

Feedback:-Feedback and types of feedback.

Oscillators:-Oscillators and its types, Essentials of a feedback LC oscillator. Hartley and Phase shift oscillators, Comparison between amplifier and oscillator.

Field Effect Transistor (FET): FET-Types, characteristics and parameters, Relation between FET parameters. FET as a common source amplifier (Qualitative).Problems(7hours)

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	B L	CO	PO
i.	Define Semiconductors and Band Gap. Explain on what basis they are classified as intrinsic and extrinsic.	L2	3	1-6, 11-12
ii.	Define PN junction. Explain its functioning in forward and reverse bias.	L1	3	1-6, 11-12
iii.	Explain the approximation used in a real diode with respect to an ideal PN Junction?	L2	3	1-6, 11-12
iv.	With a schematic diagram, explain half wave and full wave rectifiers.	L1	3	1-6, 11-12
v.	Define a Zener diode and explain how it is different from an ordinary diode using V-I curves?	L2	3	1-6, 11-12
vi.	With the schematic diagram, explain the working of voltage regulators of different types using a Zener diode.	L1	3	1-6, 11-12

vii.	Give the basic concepts used in the instruction of bipolar junction transistor and its operation.	L1	3	1-6, 11-12
viii.	Compare the V-I curve of common base common emitter and common collector BJT curves while explaining their working principles.	L2	3	1-6, 11-12
ix.	Define FET? Give its characteristics.	L1	3	1-6, 11-12
x.	Explain how a transistor can be used as an amplifier and an oscillator using a circuit diagram.	L2	3	1-6, 11-12
xi.	High Order Problems.	L3	3	1-6, 11-12
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.				
Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				
Suggested Activities				
Activity No. 7	a. Activity: Wire a DC power supply on a bread board or groove board to give a regulated output voltage of + 5 V; +15 V; Dual power output : ± 5 V; Dual power output : ± 15 V b. Use: 3-pin regulators c. Learn to identify the terminals of different types (packages) of BJTs. d. In the case of power transistors, learn how to fix a heat sink for the transistor. e. Understand the concept of virtual ground of an OP-AMP. f. Learn the different types of op-amps used for different applications. What is a buffer? Prepare a report on the application of buffers in instrumentation electronics. Seeing $\frac{1}{2}$ wave of a full wave verification on a bread board.			
Activity No. 8	(i) Learn to identify the terminals of different types (packages) of BJTs. (ii) In the case of power transistors, learn how to fix a heat sink for the transistor. (iii) Learn the difference between BJT and FET in its operational characteristics.			

Activity No. 9	<p>Build your own Regulated DC power supply (5V)</p> <p>Components required:</p> <p>1. Step down transformer- 1 No. (5 V tapping, 100 – 500 mA current rating), BY 127 semiconductor diodes – 4 Nos, Inductor -1, Capacitor - 1, 3 pin 5V regulator-1</p> <p>Wire a DC power supply on a bread board or groove board to give a regulated output voltage of + 5 V.</p> <p>Search for circuit diagram in books/net.</p>
Activity No. 10	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Form 3 groups and tell them to make a DC supply of low current of different voltages like 5V, 10V, and 15V on a breadboard</p>
Activity No. 11	<p>Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and</p>
	<p>presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.</p> <ol style="list-style-type: none"> 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. <p>Activity: Take any 3 diode and assign one to each group. Measure its resistance when dipped in ice and heating the ice till it boils. Using this data, plot calibration curve of temperature v/s resistance and also the cooling curve of temperature V/s time for the diode by each group.</p>

Thermal Physics and Electronics

Unit – 4

The Portion to be Covered

Electronics: Integrated Circuits (Analog and Digital) and their types, Operational Amplifier: Block diagram of Op-Amplifier, symbol and polarity convention, Characteristics of Op-Amp, Pin diagram of IC-741, Concept of virtual ground and summing point, Feedback concepts, Advantages of feedback, types of feedback, Expression for Gain; Op-Amp as a feedback amplifier– Non-Inverting and Inverting amplifier, Modification of input and output impedances with feedback; Differential amplifier with feedback;

Op-Amplifier Applications- Voltage Follower, Adder and Subtractor. Problems

(6 hours)

Digital: Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. Problems

(4 hours)

Boolean Algebra Theorems: Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, IC-7400 Pin diagram, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions. Boolean algebra, Truth tables, De- Morgan's theorems. Problems

(3 hours)

Topic Learning Outcomes

At the end of the topic, students should be able to:

SL No	TLO's	B L	CO	PO
i.	Define op-amps and give the characteristics of an ideal op-amp.	L1	4	1-6, 11-12
ii.	Explains an inverting and non-inverting configuration of typical op-amps, with a schematic diagram.	L2	4	1-6, 11-12
iii.	Explain how op-amps can be used as a voltage follower, with a schematic diagram and with relevant expressions.	L2	4	1-6, 11-12
iv.	Explain how op-amps can be used as a voltage follower, adder and subtractor, with a schematic diagram and with relevant expressions.	L2	4	1-6, 11-12
v.	Give different digital wave forms and explain how one can visualize the switching and logic levels.	L1	5	1-6, 11-12

vi.	Write any four-digit numbers other than zero in the decimal number system and convert that into binary and hexadecimal.	L2	5	1-6, 11-12
vii.	Write any number in a Binary System of 8 digits other than zero and convert it into decimal and hexadecimal.	L2	5	1-6, 11-12
viii.	Write any number in the hexadecimal system of 4 digits other than zero and converted it into a binary and decimal number.	L2	5	1-6, 11-12
ix.	Give simplified diagram for a given Boolean circuit diagram of logic gates, and verify using the De-Morgans theorem.	L2	5	1-6, 11-12
x.	Why are X-NOR gates called Universal Gates?	L2	5	1-6, 11-12
xi.	High Order Problems.	L3	4, 5	1-6, 11-12
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self-Directed Learning etc.				
Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				
Suggested Activities				
Activity No. 12	Learn how to implement logic functions (AND, OR, NOT) using just diodes and resistors. With a circuit diagram show how different types of gates can be built by X-NOR gates.			
Activity No. 13	Operational Amplifiers (i) Understand the concept of virtual ground of an OP-AMP. (ii) Learn the different types of op-amps used for different applications. (iii) What is a buffer? Prepare a report on buffers and its application in instrumentation electronics.			

Activity No. 14	<p>Activity A man has to take a wolf, a goat, and some cabbage across a river. His rowboat has enough room for the man plus either the wolf or the goat or the cabbage. If he takes the cabbage with him, the wolf will eat the goat. If he takes the wolf, the goat will eat the cabbage. Only when the man is present are the goat and the cabbage safe from their enemies. All the same, the man carries wolf, goat, and cabbage across the river. How? Write the truth table for the above story and implement using gates.</p> <p>Activity A locker has been rented in the bank. Express the process of opening the locker in terms of digital operation.</p> <p>Activity A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by and one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles.</p>
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Textbooks

Sl No	Title of the Book
1.	Electronic Devices and Circuits, David A. Bell, 2004, PHI, New Delhi
2.	Integrated Electronics, Jacob Millman and CC Halkias
3.	Digital Fundamentals, Floyd, 2001, PHI, New Delhi

References Books

Sl No	Title of the Book
1.	Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2.	Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
3.	A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
4.	Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5.	Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6.	An Introduction to Thermal Physics, Daniel V Schroeder, 2020, Oxford University Press

Formative Assessment

Assessment	Mark S
Internal Assessment	20
REU based Group Activity (Conduction, Report, Presentation)	20
Total	40

Course outcomes:

- Improves the skill of handling optical equipments.
- Learns the calibration of Spectrometer

List of Experiments to be performed in the Laboratory	
Note: Minimum Eight experiments to be carried out	
1.	Mechanical Equivalent of Heat, J by Electrical method.
2.	Coefficient of thermal conductivity of Copper by Searle's apparatus.
3.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
4.	Determination of Stefan's constant/ Verification of Stefan's law.
5.	Variation of thermo-emf across two junctions of a thermocouple with temperature.
6.	Verification of Clausius –Clapeyron equation and determination of specific enthalpy.
7.	V-I Characteristics of Silicon & Germanium PN Junction diodes (FB & RB)
8	Full -Wave bridge Rectifier Without Filter(internalresistance andvoltage regulation).
9	Full- Wave Rectifier bridge with Π section Filter (internalresistance andvoltage regulation).
10.	Zenerdiode asvoltage regulatorusingbridge rectifierpowersupply.
11.	H- Parameter of transistor.
12.	Frequency response of CE Amplifier
13.	FET-staticcharacteristics and parameters.
14.	Frequency response of FET Amplifier.
15.	Non-inverting and Inverting using op-amp circuits.
16.	Adder and Subtractor using op-amp circuits.
17.	Realization of basic gates using NAND gate.
18.	Verification Boolean Algebra using NAND gate using IC-7400.
19.	Verification of De -Morgan's laws using IC-7400.

Reference Book for Laboratory Experiments	
Sl No	Title of the Book
1	Basic Electronics Lab (P242) Manual 2015-16, National Institute of Science Education and Research, Bhubaneswar, 2015.
2	Suggested Readings: 1. B.L. Worsnop, H.T. Flint, “Advanced Practical Physics for Students”, Methuen & Co., Ltd., London, 1962, 9e. 2. S. Panigrahi, B. Mallick, “Engineering Practical Physics”, Cengage Learning India Pvt. Ltd., 2015, 1e.

OPEN ELECTIVE PAPER

Year	2	Course Code: 21BSC4O4PHY4	Credits	03
Sem.	4		Course Title: ELECTRICAL INSTRUMENTS	Hours
Formative Assessment Marks: 40		Summative Assessment Marks: 60		Duration of ESA:.02 hrs.
Course Outcomes				
<ul style="list-style-type: none"> • Understands the working principle of electrical instruments and networking. • Enables the students to design and the electrical circuits, networks and appliances through hands on mode. • Acquire basic knowledge of solid state electronic devices. • Get exposed to various aspects of instruments & their usage. 				
Unit No.	Course Content			
Unit I	<p>Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simplecircuits with dc excitation. Ammeters,voltmeters: (DC/AC)</p> <p>Representation of sinusoidal waveforms, peak and rms values, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. Wattmeters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy meter .</p> <p style="text-align: right;">(10 Hours)</p>			
Unit II	<p>Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasordiagram, methods of minimizing errors; testing and applications.</p> <p>Galvanometers: General principle andperformance equations of D'Arsonval Galvanometers, Vibration Galva nometer and Ballistic Galvanometer. Potentiometers: DCPotentiometer, Crompton potentio meter, construction, standardization, application. AC Potentio meter, Drysdalepolarpotentio meter; standardization, application.</p> <p style="text-align: right;">(10 Hours)</p>			
Unit III	<p>DC/AC Bridges: General equations for bridge balance, measurement of self inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge.</p> <p>Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer.</p> <p style="text-align: right;">(10 Hours)</p>			

Unit IV	<p>CRO: Block diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency, phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation.</p> <p>Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.</p> <p style="text-align: right;">(10 Hours)</p>
Activity No. 1	Identify variety of electrical switches and note down their applications/utility.
Activity No. 2	Identify the hazards involved in handling electrical circuits and instruments, make a list of safety precautions as well as first aid for electrical shocks.
Activity No. 3	Make a study of importance of grounding in electrical circuits.
Activity No. 4	Prepare a detailed account of various methods of earthing and their utility/applications
Activity No. 5	Prepare a document on evolution of incandescent bulbs to the present day LED lights
Activity No.6	Make a comparative study of Fuses, MCB, ELCB and Relays highlighting their use and applications
Text Books	
1. AK.Sawhney, A Course in Elec.&Electronics Measurements&Instrumentation ,Dhanpatrai& Co. 1978	
2. A.D. Helfrick& W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques PHI,2016	
Reference Books	
1. D C Kulshreshtha, Basic Electrical Engineering, McGraw Hill Publications,2019	
2. David G Alciatore and Michel B Histan, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005	
3. Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India2009	
List of Experiments to be performed in the Laboratory	
	Experiments
1	Introduction to Lab Equipment
2	Voltmeter Design
3	Ammeter Design
4	Ohmmeter Design
5	Multimeter Design
6	Measurement of Resistance using Wheatstone Bridge
7	Measurement of Capacitance using Schering Bridge
8	Measurement of Inductance using Maxwell Bridge
9	Measurement of Light Intensity
10	Measurement of Temperature

Reference Book for Laboratory Experiments
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1. AK.SawhneyACourseinElec.&Electronics Measurements&Instrumentation:

2. Helfrick& Cooper, Modern Electronic Instrumentation and Measurement Techniques:
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