2019 - 2020 (I)

File No.

Bharath

INSTITUTE OF HIGHER EDUCATION AND RESEARCH

(Declared As Deemed-to-be University u / s 3 Of UGC Act, 1956.)

173, Agharam Road, Selaiyur, Tambaram, Chennai - 600 073

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COURSE FILE – 2019 -2020 (SEM I)

Course Name: WAVES AND OPTICS

Course Code: U18BSPH101

Year : ____________________

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COURSE FILE

FACULTY	Dr. C. RATHIKA THAYA KUMARI	FACULTY DEPT	PHYSICS
SUBJECT	WAVES AND OPTICS	SUBJECT CODE	U18BSPH101
YEAR	2019-2020	SEMESTER	I
DEG & BRANCH	B.TECH (ALL BRANCHES)	DURATION	45 Hours

SL.NO	DETAILS IN COURSE FILE	REMARKS
1.	LEARNING OUTCOMES	✓
2.	LESSON PLAN	✓
3.	CO-PO MAPPING	✓
4.	INDIVIDUAL TIME TABLE	✓
5.	SYLLABUS WITH COURSE OUTCOMES	✓
6.	LECTURE NOTES (FOR ALL UNITS)	✓
7.	INTERNAL ASSESSMENT I - QUESTION PAPER	✓
8.	INTERNAL ASSESSMENT I - KEY	✓
9.	INTERNAL ASSESSMENT I – SAMPLE ANSWER SHEETS	✓
10.	INTERNAL ASSESSMENT II - QUESTION PAPER	✓
11.	INTERNAL ASSESSMENT II - KEY	✓
12.	INTERNAL ASSESSMENT II-SAMPLE ANSWER SHEETS	✓
13.	ASSIGNMENT QUESTIONS	✓
14.	SAMPLE ASSIGNMENTS	✓
15.	END SEMESTER QUESTION PAPER	✓
16.	END SEMESTER ANSWER KEY	✓
17.	TEXT BOOK AND REFERENCE BOOK	✓
18.	QUESTION BANK	✓
19.	STUDENT PERFORMANCE RECORD	✓
20.	STUDENT ATTENDANCE RECORD	✓
21.	COURSE END SURVEY	✓
22.	CO ATTAINMENT	✓

STAFF HOD DEAN S&H

Dr. R. VELAVAN, M.Sc.,M.Phil.,Ph.D.,
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Department of Physics
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SCHOOL OF BASIC SCIENCES

DEPARTMENT OF PHYSICS

LEARNING OUTCOMES

Course Name: **WAVES AND OPTICS**

Course Code: **U18BSPH101**

The learning of waves and optics helps the:

- Students to bring physics to the community through outreach.
- Students to expand the basic knowledge of optics combining with contemporary technology to excel in their engineering career.
- Students to design the importance of hall acoustics and noise reduction
- Students to extend the acquired basic knowledge in data storage, data transfer and telecommunications.
- Students to apply the wide range of applications of Ultrasonic waves & Laser light to design customized instruments in their discipline.

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Lesson Plan

Name of the Department : Physics

Name of the School : School of Basic Sciences

Program Name/Code : B.Tech, I Year (Common to all branches)

Academic Year / Semester : 2019-2020/ODD

Course Name/Code : Waves and Optics / U18BSPH101

a. No. of Credits : 3

b. Total Contact Hours : 45

Staff Name / ID : Dr. C. Rathika Thaya Kumari

Hours	Topic	CO	Reference	Teaching Tool	Proposed Date	Completed Date	Remarks
UNIT 1 NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES IN ONE DIMENSION							
1	Introduction	CO1	R1	T1	29.08.2019	29.08.2019	
2	Transverse wave on a string, the wave equation on a string	CO1	R1	T1	30.08.2019	30.08.2019	
3	Harmonic waves reflection and transmission of waves at a boundary	CO1	R1	T1	02.09.2019	02.09.2019	
4	Standing waves,	CO1	R1	T2	05.09.2019	05.09.2019	
5	Longitudinal waves and the wave equation for them	CO1	R1	T1	06.09.2019	06.09.2019	
6	acoustics waves and speed of sound	CO1	R1	T1	09.09.2019	09.09.2019	
7	Waves with dispersion	CO1	R1	T1	12.09.2019	12.09.2019	
8	Superposition of waves	CO1	R1	T4	13.09.2019	13.09.2019	
9	Wave groups and group velocity	CO1	R1	T4	16.09.2019	16.09.2019	

			UNIT 2 ULTRASONIC WAVES				
1	Production of ultrasonic by magnetostriction	CO2	R2	T1	19.09.2019	19.09.2019	
2	piezoelectric methods	CO2	R2	T1	20.09.2019	20.09.2019	
3	Acoustic grating	CO2	R2	T1	23.09.2019	23.09.2019	
4	Detection	CO2	R2	T2	26.09.2019	26.09.2019	
5	Non Destructive Testing	CO2	R2	T1	27.09.2019	27.09.2019	
6	Pulse echo system through transmission and reflection modes	CO2	R2	T1	30.09.2019	30.09.2019	
7	A,B and C – scan displays	CO2	R2	T1	03.10.2019	03.10.2019	
8	Industrial and Medica applications	CO2	R2	T4	04.10.2019	04.10.2019	
9	Sonogram		R2	T3	07.10.2019	07.10.2019	
			UNIT 3 THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS				
1	Fermat's principle of stationary time and its applications e.g. in explaining mirage effect	CO3	R1	T1	10.10.2019	10.10.2019	
2	Laws of reflection and refraction	CO3	R1	T1	11.10.2019	11.10.2019	
3	Light as an electromagnetic wave	CO3	R1	T2	14.10.2019	14.10.2019	
4	Fresnel equations	CO3	R1	T1	17.10.2019	17.10.2019	
5	Reflectance and transmittance	CO3	R1	T1	18.10.2019	18.10.2019	
6	Brewster's angle	CO3	R1	T1	21.10.2019	21.10.2019	
7	Total internal reflection	CO3	R1	T2	24.10.2019	24.10.2019	
8	Evanescent wave.	CO3	R1	T1	25.10.2019	25.10.2019	
9	Mirrors and lenses and optica instruments based on them.	CO3	R1	T3	28.10.2019	28.10.2019	

			UNIT 4 WAVE OPTICS				
1	Huygens' principle	CO4	R1	T1	31.10.2019	31.10.2019	
2	superposition of waves	CO4	R1	T1	01.11.2019	01.11.2019	
3	interference of light by wave front splitting	CO4	R1	T1	04.11.2019	04.11.2019	
4	amplitude splitting	CO4	R1	T1	07.11.2019	07.11.2019	
5	Young's slit experiment	CO4	R1	T2	08.11.2019	08.11.2019	
6	Newton's ring	CO4	R2	T1	11.11.2019	11.11.2019	
7	Michelson interferometer	CO4	R2	T1	14.11.2019	14.11.2019	
8	Fraunhofer diffraction from a single slit and a circular aperture	CO4	R2	T5	15.11.2019	15.11.2019	
9	Diffraction gratings and their resolving power.	CO4	R2	T1	31.10.2019	31.10.2019	
			UNIT 5 LASERS				
1	Einstein's theory of matter radiation interaction and A and B coefficients	CO5	R3	T1	18.11.2019	18.11.2019	
[illegible]	amplification of light by population inversion	CO5	R3	T1	21.11.2019	21.11.2019	
3	Different types of lasers	CO5	R3	T2	22.11.2019	22.11.2019	
4	Gas lasers (He-Ne, CO2)	CO5	R3	T2	25.11.2019	25.11.2019	
5	Solid-state lasers(Neodymium)	CO5	R3	T4	28.11.2019	28.11.2019	
6	Properties of laser beams	CO5	R3	T1	29.11.2019	29.11.2019	
7	Mono-chromaticity,	CO5	R3	T1	02.12.2019	02.12.2019	

8	Coherence, directionality and brightness	CO5	R3	T1	05.12.2019	05.12.2019	
9	Applications of lasers in science, engineering and medicine.	CO5	R10	T3	06.12.2019	06.12.2019	

REFERENCE CODE	DESCRIPTION
R1	M.N. Avadhanulu and P.G. Kshirsagar, "A Textbook of Engineering Physics" S.Chand Publishers, 2016
R2	G.Senthil Kumar, "Engineering Physics", VRB publishers, Chennai, 2015
R3	BrijLal and Subramanian, "Waves and Oscillation", VikasPublishsing House, 2011
R4	R.Murugesan,"Optics and Spectroscopy", S.Chand Publishers, 2015
R5	BrijLal and Subramanian,"Optics", S.Chand Publishers 2006
R6	Ian G. Main, "Vibration and waves in physics", Cambridge University Press, 1978
R7	H.J. Pain, "The physics of vibrations and waves", 6th edition, Wiley 2006
R8	AjoyGhatak, "Optics", Tata McGraw-Hill publishing company, New Delhi, 2009
R9	O. Svelto, "Principles of Lasers", Springer, 2010
R10	Online reference – Waves & Oscillations by Prof. M. S. Santhanam, IISER Pune. Web link: https://onlinecourses.nptel.ac.in/noc19_ph18

TYPE CODE	TEACHING TOOL PLANNED
T1	Black Board
T2	Power Point Presentation
T3	Video Presentation
T4	Seminar
T5	Tutorial & Problem solving

Prepared By	Dr. C. Rathika Thaya Kumari Course Coordinator	
Verified By	Dr. R. Velavan HOD	

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CO-PO MAPPING

Name of the School : School of Basic Sciences

Name of the Department : PHYSICS

Program Name/Code : B.Tech. (All Branches)

Course Name/Code : WAVES and OPTICS / U18BSPH101

Course Coordinator details

a. Name/ID :Dr. C. Rathika Thaya Kumari
b. Designation : Associate Professor
c. Department : Physics

List of POs:

Engineering Graduates will be able to:

PO1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

List of PSOs:

PSO 1

PSO 2 :

PSO n : ______

CO-PO Mapping

Course outcomes	
CO1	Describe the basic concept of waves (Remember)
CO2	Identify the importance of Ultrasonic waves (Understand)
CO3	Recognizethe propagation of light and geometrical optics (Remember)
CO4	Discuss the optical phenomenon like interference, diffraction and superposition of waves (Understand)
CO5	Observe the concept of laser and its applications (Understand)
CO6	Examine the properties of light and sound waves and its wide range of applications (Apply)

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	H		M		L							
CO2	H	H	M									
CO3	H		M									
CO4	H		M		L							
CO5	H									H		M
CO6	H	M	H							H		

Note: L – Low; M – Medium; H - High

Prepared by	Course Coordinator **Dr. C. RathikaThayaKumari**	Signature
Verified &Forwardedby	HoD **Dr. R. Velavan**	Signature

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SCHOOL OF BASIC SCIENCES

DEPARTMENT OF PHYSICS

DE

NAME OF THE FACULTY: DR. C. RATHIKA THAYA KUMARI

COURSE NAME: WAVES AND OPTICS

COURSE CODE: U18BSPH101

DAY/ HOURS	1 9.00AM - 9.50AM	2 9.50AM - 10.40AM		3 10.50AM - 11.40AM	4 11.40AM - 12.30PM		5 1.30PM - 2.10PM	6 2.10PM - 2.50PM	7 2.50PM - 3.30PM
MON		CSE-A	BREAK			LUNCH			
TUE									
WED	CSE-A								
THUR									
FRI		CSE-A							

CRathi

R. Velavan

HOD

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U18BSPH101	WAVES AND OPTICS (For B.Tech –Common to all branches)	L	T	P	C
	Total contact hours -45	3	0	0	3
	Prerequisite: +2				
	Course offered by –Department of Physics				
	Data Book/Codes /Standards : Higher Secondary				

COURSE OUTCOMES(COs)	
CO1	Describe the basic concept of waves (Remember)
CO2	Identify the importance of Ultrasonic waves (Understand)
CO3	Recognize the propagation of light and geometrical optics (Remember)
CO4	Infer the optical phenomenon like interference, diffraction and superposition of waves (Understand)
CO5	Observe the concept of laser in practical applications (Understand)
CO6	Examine the properties of light and sound waves and its wide range of applications (Apply)

Mapping of course outcomes with programme outcomes(POs)

(H/M/L indicates strength of correlation) H-High, M-Medium, L-Low

1	COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
2	CO1	H		M		L							
	CO2	H	H	M		H							M
	CO3	H		M									
	CO4	H		M		L							
	CO5	H									H		M
	CO6	H	M	H							H		
3	Category	**Basics Sciences(BS)**											
4	**Approval**	47th Meeting of Academic Council held in Aug, 2018											

R. S. Velavan

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UNIT 1 NON-DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES IN ONE DIMENSION

Introduction - Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, standing waves, longitudinal waves and the wave equation for them, acoustics waves and speed of sound. Waves with dispersion, superposition of waves, wave groups and group velocity. **(Contact Hours - 9)**

UNIT 2 ULTRASONIC WAVES

Production of ultrasonic by magnetostriction and piezoelectric methods - acoustic grating – Detection - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C – scan displays, Industrial and Medical applications – Sonogram. **(Contact Hours - 9)**

UNIT 3 THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS

Fermat's principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster's angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them. **(Contact Hours - 9)**

UNIT 4 WAVE OPTICS

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer. Fraunhofer diffraction from a single slit and a circular aperture, Diffraction gratings and their resolving power. **(Contact Hours - 9)**

UNIT 5 LASERS

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers(Neodymium), Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, applications of lasers in science, engineering and medicine. **(Contact Hours - 9)**

TEXT BOOKS

1) M.N. Avadhanulu and P.G. Kshirsagar, "A Textbook of Engineering Physics" S.Chand Publishers, 2016.
2) G.Senthil Kumar, "Engineering Physics", VRB publishers, Chennai, 2015.

REFERENCE BOOKS

1) BrijLal and Subramanian, "Waves and Oscillation", VikasPublishsing House, 2011
2) R.Murugesan,"Optics and Spectroscopy", S.Chand Publishers, 2015
3) BrijLal and Subramanian,"Optics", S.Chand Publishers 2006
4) Ian G. Main, "Vibration and waves in physics", Cambridge University Press, 1978
5) H.J. Pain, "The physics of vibrations and waves", 6th edition, Wiley 2006
6) AjoyGhatak, "Optics", Tata McGraw-Hill publishing company, New Delhi, 2009
7) O. Svelto, "Principles of Lasers", Springer, 2010
8) Online reference – Waves & Oscillations by Prof. M. S. Santhanam, IISER Pune.
   Web link: https://onlinecourses.nptel.ac.in/noc19_ph18.

Waves and Optics.

Unit - I

Introduction - Waves.

Whenever a disturbance is created in a medium, local displacement of Particles from equilibrium is caused. When a Particle is disturbed, restoring force is Provided by the intermolecular forces which in turn brings the former Particle to its original position and the later begins to displace (oscillate). In doing so, it affects the adjacent molecules, which are in turn set into Oscillations.

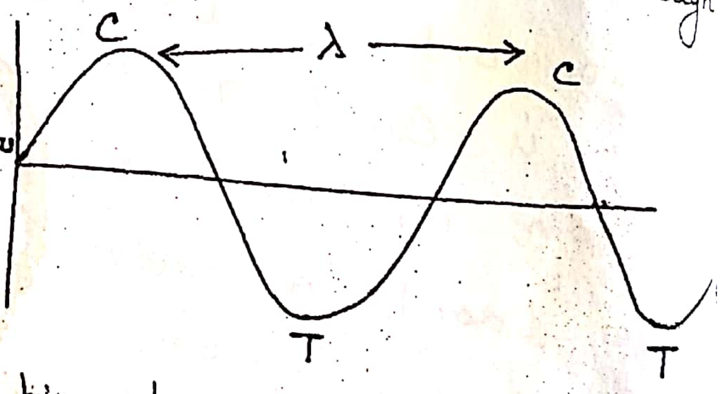
Definition: Waves Can be described as, Any disturbance which travels through the medium due to the ~~P~~ repeated Periodic motion of the Particles about their mean Position, and transporting energy from one Point to another without transporting matter.

A Wave is Characterized by the following Parameters :-

The Waves in a pond is nothing but the rearrangement of the surface of water. There could be no wave, without water. So, it is clear that the wave transports its energy on the surface of water. i.e the energy supplied a stone into water is transferred from one point to another. Therefore, the waves are so to be an energy transport phenomena.

In case of water waves, the wave moves with the help of crests and troughs travelling away from the centre of disturbance are called travelling waves or Progressive waves.

C – Crest
T – Trough



The following Parameters of the travelling waves are,

Time Period → The time taken by the particle to complete one cycle of oscillation as the wave Propagates is called Time Period (T).

Wavelength → The distance between any two successive crests or troughs is called Wavelength (λ).

Amplitude (A) → The maximum displacement in a Waveform is known as amplitude.

Velocity (v) → For each oscillation, the wave moves forward to a distance λ. If there are ν vibrations in one second, then the wave moves to a distance νλ. Hence, the velocity of a wave is the product of its wavelength and frequency.

$$V = \nu\lambda$$

Phase angle (φ) → The direction of the deviation of the particles from one point to another point along the wave is called phase angle.

Intensity (I) → The average energy transferred by a wave in unit time through unit area perpendicular to the direction of propagation is called intensity of the wave

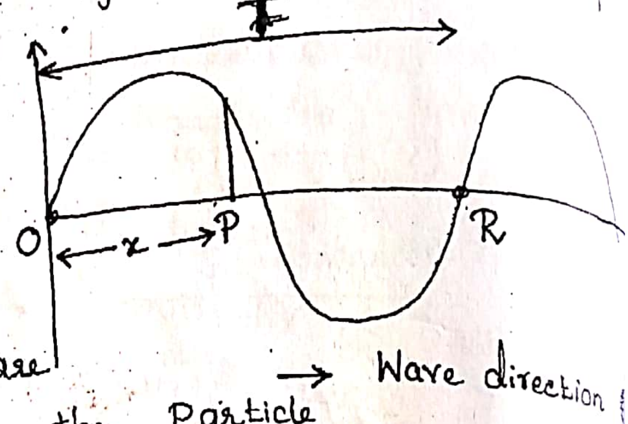
$$I \propto |A|^2.$$

Q1 c

Wave Equation of Longitudinal Waves:

Wave equation of an object gives the position of the object as a function of time.

Consider the harmonic motion of a particle in a medium.



As the oscillations are from point to point, the particle in the medium will be in different position at different times. Hence, the displacement of a particle in a medium is represented as a function of space coordinates and time. Thus,

the displacement, $y = f(x, t)$ —— (1)

In case of a one dimensional wave along positive x-axis, the displacement is represented as a function of time, at position $x = 0$.

$\therefore \quad y = f(t)$

Since, the oscillations are sinusoidal, we can represent the displacement as,

$$y = A \sin \omega t$$

$$y = A \sin 2\pi \nu t \qquad \text{—— (2)}$$

The wave is travelling with a velocity v.
Then, after time t, it moved through the distance, $x = vt$. $v = \frac{x}{t}$

$\therefore$ The displacement at p; $y = f(x - vt)$ —— ③

We know, $v = \nu\lambda$

$$\frac{x}{t} = \nu\lambda$$

$$\boxed{\frac{x}{\lambda t} = \nu}$$ —— ④

Hence Eqn (2) can be written as,

$$y = A \sin 2\pi\left(\frac{x}{\lambda}\right)$$ —— ⑤

This eqn(5) clearly shows that the wave is periodic.

Thus, the displacement ~~of any~~ at point p on a harmonic wave in terms of space and time as,

$$y = A \sin\left[\frac{2\pi}{\lambda}(x - vt)\right]$$ —— ⑥

$$\therefore y = A \sin k(x - vt)$$ —— ⑦

Where $k = \frac{2\pi}{\lambda}$, is known as propagation constant or wave number.

Eqn (7) can be rewritten as,

$$kx - kvt$$
$$kx - \frac{2\pi}{\lambda} \cdot \nu\lambda t$$
$$\omega t$$

$$y = A \sin(kx - \omega t)$$ —— ⑧

Eqn (8) represents the wave equation.

Scanned with CamScanner

Types of Waves :

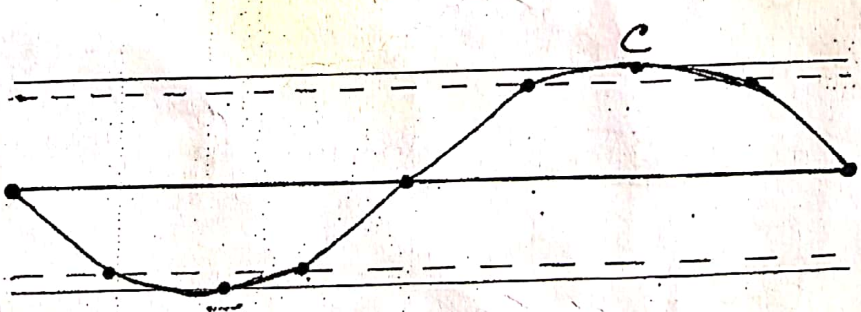
Basically, there are two types of Waves.

1. Transverse Waves
2. Longitudinal Waves.

Transverse Waves :

(I)

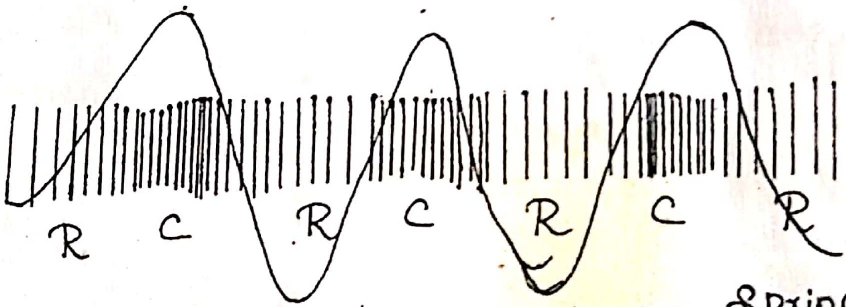
* A transverse wave is a wave in which Particles of the medium moves in a direction Perpendicular to the direction of Propagation.
* The direction of displacement of each Particle is at right angles to the direction of Propagation of the wave, is said to be Transverse
* Transverse Waves can exist on the surface of a liquid,
* Hence, ripples on water surfaces are transverse waves.
* Transverse Waves need a relatively rigid medium to transmit their energy.



* The maximum distance from the mean Position is Called Crest.
* The maximum distance from the mean Position is Called trough.

Longitudinal Waves :

* A longitudinal wave is a wave in which the Particles of the medium moves in a direction Parallel to the direction of Propagation.
* The direction of displacement of Particle is back and forth along the direction of Propagation of the wave, is said to be longitudinal Wave.
* Longitudinal waves travel through the bulk of a fluid (liquid or gas).



* Example : 1. If one end of a Spring is Pushed and then Pulled, a longitudina disturbance will Propagate along the String.

2. Sound waves are longitudinal waves.

Wave Equation:

It is the equation, that gives the Position of the object as a function of time.

Non - Dispersive System is a String with transverse Waves on it.

Long

Transverse Wave on a String:

* A String is a Perfect elastic, uniform flexible Cord having very large length in Comparison to its diameter.
* When a stretched string is Plucked in a direction Perpendicular to its length, transverse Vibrations are Produced in the String.
* This is due to the fact that, tension in the string tends to bring back to its mean position but due to inertia, the string overshoots and goes to other extreme.

In this way, transverse Vibrations are setup in the string.

Wave Equation On a String.

Consider a String PQ Stretched by tension T. Let the String be Plucked at Centre O and left free. As a result, transverse Vibrations are set up in the string.

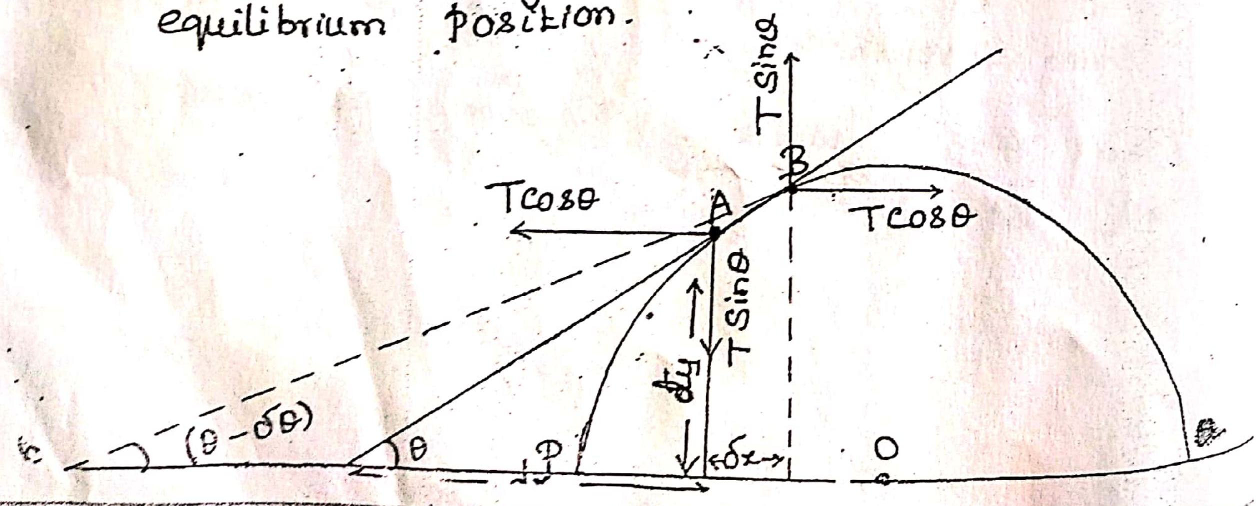
Here, Consider a small element AB of length δx. The tangents at the point A and B represents their tension T.

The tension T at A can be resolved into two components,

Parallel Component, T Cosθ and

Perpendicular Component, T Sinθ (downward) which makes an angle θ with x-axis.

Similarly, Tension T at B can be resolved into Parallel Component T Cosθ and Perpendicular Component T Sinθ (upward) makes angle $\theta - \delta\theta$ with the x-axis. Here ⊥r Components brings the string back to the equilibrium position.



At A,

The ⊥r (downward) Component of Tension,

$= T \sin\theta$, when θ is small

$\sin\theta = \tan\theta$

$= T \tan\theta$.

But $\tan\theta = \frac{dy}{dx}$, is the slope.

$\therefore$ ⊥r Component (downward) at A $= T\frac{dy}{dx}$ —— (1)

The rate of change of Slope with respect to the length element, $= \frac{d}{dx}\left(\frac{dy}{dx}\right)$.

$= \frac{d^2y}{dx^2}$

$\therefore$ The change in Slope for a distance δx,

$= \frac{d^2y}{dx^2} \cdot \delta x$.

At B,

The ⊥r (upward) Component of Tension,

$= T \sin(\theta - \delta\theta)$

$= T \tan(\theta - \delta\theta)$

The Slope at B $= \frac{dy}{dx} - \frac{d^2y}{dx^2}\delta x$.

$\therefore$ ⊥r (upward) Component at B, $= T\left[\frac{dy}{dx} - \frac{d^2y}{dx^2} \cdot \delta x\right]$ —— (2)

From equations (1) & (2), the net ~~downward~~ tension is given by,

$$F = T\frac{dy}{dx} - T\left[\frac{dy}{dx} - \frac{d^2y}{dx^2}.\delta x\right]$$

$$F = T\frac{d^2y}{dx^2}.\delta x \quad \text{—— (3)}$$

If m is the mass / unit length, then

mass of the element AB = $m\,\delta x$

Acceleration of the element in the direction of y-axis } = $\frac{d^2y}{dt^2}$.

∴ Force acting on the element = $m\,\delta x.\frac{d^2y}{dt^2}$ —— (4)

Equating eqns (3) & (4),

$$m\,\delta x.\frac{d^2y}{dt^2} = T\frac{d^2y}{dx^2}.\delta x.$$

$$\boxed{\frac{d^2y}{dt^2} = \frac{T}{m}\frac{d^2y}{dx^2}} \quad \text{—— (5)}$$

This is the required Wave Equation. This is quite similar to the standard equation of wave motion as,

$$\frac{d^2y}{dt^2} = v^2\frac{d^2y}{dx^2}$$, v is the Velocity of Propagation of the wave

Special Cases:

Equating eqn (5) & (6),

$$V^2 = \frac{T}{m}$$

$$\therefore \boxed{V = \sqrt{\frac{T}{m}}}$$

We know, $V = n\lambda$. In our case, the string of length l vibrates in 'p' segments, then the length of each segment is (l/p) corresponds to half wavelength.

$$\therefore \frac{l}{p} = \frac{\lambda}{2}, \Rightarrow \boxed{\lambda = \frac{2l}{p}}$$

Substituting λ in 'V',

$$V = n\lambda = n \cdot \frac{2l}{p}$$

$$\sqrt{\frac{T}{m}} = n \cdot \frac{2l}{p}$$

$$\boxed{\frac{p}{2l}\sqrt{\frac{T}{m}} = n}$$

This is the frequency of transverse wave.

10 mark

Characteristics of Wave motion:

1. It is the disturbance Produced in the medium by the repeated Periodic motion of the medium Particle.
2. The wave move forward where as the Particle of the medium Vibrate about the mean Position.
3. There is a regular Phase difference exist between the Particles of the medium.
4. The Velocity of the wave is uniform throughout the medium.
5. Each Particle Vibrates about its mean Position with the same amplitude and time Period.
6. The Velocity of the Particle is different at different Points.
7. The Velocity of the Particle is different from the Velocity of the wave in the medium.

11

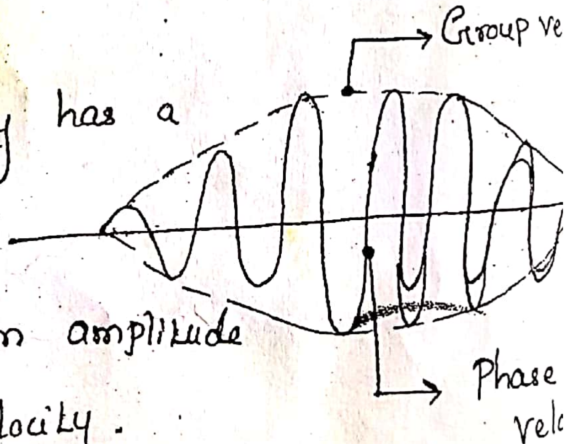
Dispersion in Waves:

When a Pulse, travelling through a medium, it spreads out through a medi and undergoes a change in its shape. T Phenomenon is known as dispersion.

Example: 1. Motion of waves in water

2. Sunlight spreads into spectrum of Colours, while passing through a

Wave Packet: A Combination of harmonic waves with wave numbers spread over a range ΔK will Produce a Wave group or wave Packet. The Superposition of a very la number of harmonic waves differing in frequency will Produce a single wave Pack The waves Cancel each other everywhere e in a small region.

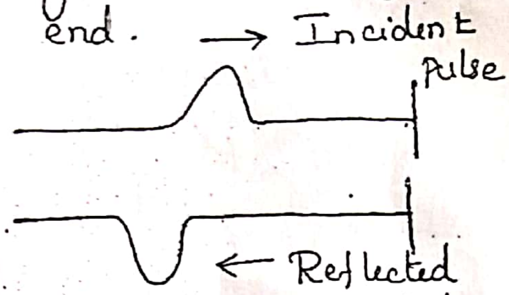


The wave group generally has a maximum amplitude at a Particular ~~Value~~ Point and the Velocity of this maximum amplitude Point is called group Velocity.

The Velocity of Propagation of a wave 'V_P' is called Phase Velocity. $V_P = \nu\lambda$.

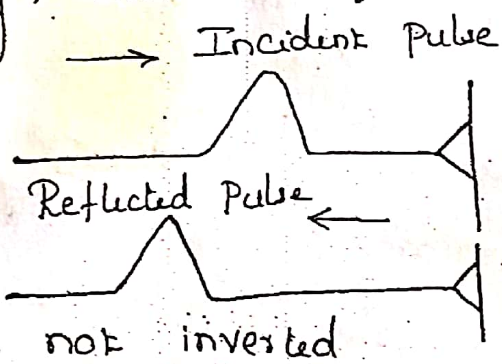
Reflection and Transmission of Waves at a Boundary. [6 Marks]

1\. Consider a wave travelling on a string, which is attached at one end.



* When the incident Pulse reaches the support, the wave is reflected and inverted along the string in the opposite direction.
* This inversion is because, the string Produces an upward force on the support and causes equal and opposite downward force on the string.

Consider a wave travelling on a string, which is tied in a ring, and can free to move vertically.



* When the incident Pulse reaches the ring, the wave is reflected and is not inverted along the string in the opposite direction. This is because, When it reaches the ring, the force on the free end of the string causes the ring to accelerate upward and the downward force pulls the ring back down. This causes the reflected pulse which is not inverted.

(1). UNIT - 2

Ultrasonics

①

Ultrasonics is a branch of Physics which deals with the study of high freq sound waves.

Sound is Produced by Vibrating bodies. Based on its frequency, Sound is classified into three categories. They are, Infrasonics, Audible waves and ultrasonic Waves.

* Infrasonic Waves — Sound waves with frequencies below 20 Hz. They are not audible to human ears.

* Audible Waves - Sound waves with frequencies between 20 Hz and 20,000 Hz. They are audible to human ear.

* Ultrasonic Waves - Sound waves with frequencies above 20,000 Hz. They are not audible to human ear. Bats are blind, but they can generate ultrasonic Waves, which helps to detect objects and obstacles by receiving the echo.

Properties :

They are highly energetic, because it is a high frequency Wave.

They can travel through a longer ~~medium~~ distance without any loss in medium.

Like ordinary sound waves, this ultrasonic Waves are also reflected, refracted and transmitted.

They can generate heat, when absorbed by medium.

(2) Ultrasonic Waves are widely used in Engineering and Industries, Marine applications, Medical diagnostics, Non Destructive testing etc.

Production of ultrasonic Waves.

There are two important methods for Producing ultrasonic waves.

1. MagnetoStriction Generator.
2. Piezo Electric Generator.

MagnetoStriction Effect:

When a ferromagnetic rod is Placed in an alternating magnetic field, the rod undergoes alternate Contractions and expansions at a frequency equal to the freq of applied field. This effect is Called magnetoStriction Effect.

MagnetoStriction Generator.

This is used to generate ultrasonic waves.

Principle:

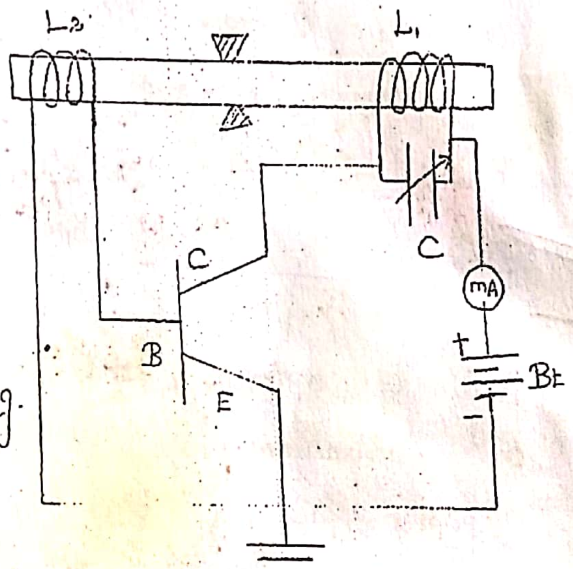
- It works on the Principle of magnetoStriction effect.
- When a ferromagnetic rod is Placed in an alternating mag. field, the rod undergoes change in length.
- At resonance, it Produces ultrasonic waves.

Construction:

A ferromagnetic rod is clamped at the Centre. The two Coils L_1 and L_2 are wounded on both

both ends of the rod. The Variable Capacitor is Connected in Parallel to L_1. Now this forms a resonant Circuit, and is Connected to the Collector of the transistor. The base is Connected to L_2. The other end of L_2 is Connected to the resonant Circuit thro' Battery and milli ammeter. Milliammeter will measure the Current. A battery Provides necessary biasing to the transistor.

<u>Working</u>:



1. When the battery is Switched On, Current goes to the Resonant Circuit.
2. This alternating Current Provides alternating mag. field and makes the rod to Vibrate.
3. The alternating mag. field changes the flux in the Coil L_2, and Varying emf is fed back into the base of transistor.
4. Rod Vibrates. By adjusting the Variable Condenser the freq. of oscillatory circuit is made equal to the natural freq of the rod. This is known as Resonance.
5. Due to Resonance, rod Vibrates with maximum freq. and ultrasonic waves are Produced.

Freq. of Oscillatory Ckt = Freq. of Vib. rod

$$\frac{1}{2\pi\sqrt{LC}} = \frac{1}{2l}\sqrt{\frac{E}{\rho}}$$

This is the resonance Condition.

Thus, ultrasonic waves are Produced with a freq of $f = \frac{1}{2l}\sqrt{\frac{E}{\rho}}$.

Piezo Electric Effect:

When a mechanical Stress is applied to one Pair of opposite faces of a crystal, then equal and opposite charges are developed on the other Pair of opposite faces of the crystal. This is Known as Piezo Electric effect.

Inverse Piezo Electric Effect:

When an electric field is applied to one Pair of opposite faces of a crystal, then expansion or Contraction is developed on the other Pair of opposite faces of the crystal. This is Known as Inverse Piezo Electric Effect.

Examples: Quartz, Rochelle Salt, tourmaline and Zinc blende are Piezo electric materials.

Last 4, 0.
(?) 1, 4, 5, 7 (A)

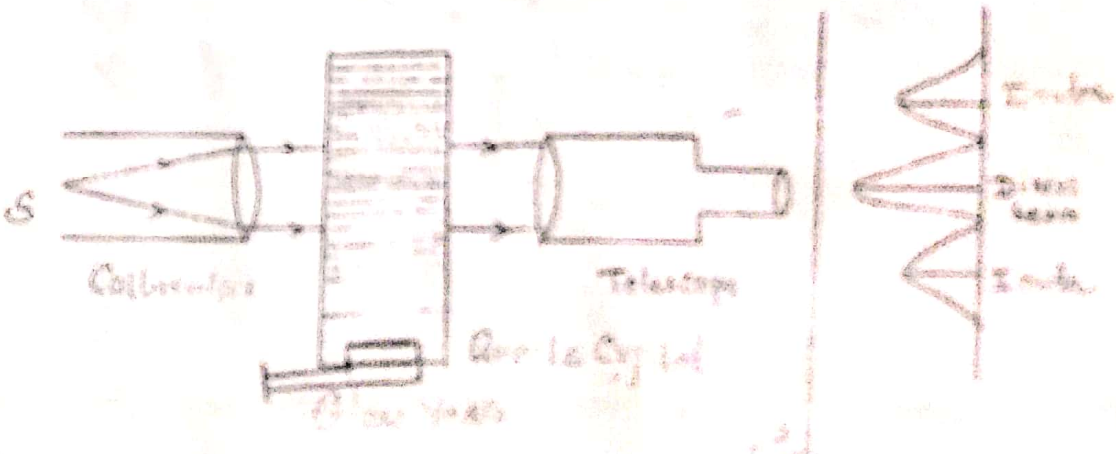
Acoustic Grating

- When ultrasonic waves passes through a liquid, stationary waves are produced due to alternate compression and rarefaction.
- If a monochromatic light is passed through a liquid, the region of compression act as a opaque medium and rarefaction act as a transparent medium.
- Now, liquid behaves as a diffraction grating called acoustic grating.

Experimental arrangement:

Principle:
- Liq. behaves as a grating.
- Light falls on grating, light get diffracted.
- Using diffraction formula, velocity can be determined.

- It consists of a glass vessel with transparent liquid.
- A Quartz Crystal is placed at the bottom of a glass vessel containing liquid.
- Due to the superposition of the incident and reflected waves, longitudinal stationary wave pattern is formed in the liquid with nodes and antinodes.

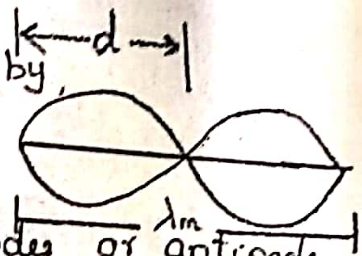


- At nodes, density of liquid is maximum and at antinodes, density of liquid is minimum.
- Now, it acts as an acoustic grating.
- This acoustic grating is mounted on the Prism table of the Spectrometer.
- A Parallel beam of monochromatic light from Collimator falls on acoustic grating and get diffracted.
- The diffracted Pattern is seen through the telescope.
- The diffracted Pattern Consists of a Central bright maximum followed by first order, Second order..... maxima on both sides.
- The angle of diffraction θ from the Central maximum for any order n is measured.

Theory :

The Grating formula is given by,

$$d \sin\theta = n\lambda.$$



Where, $d \rightarrow$ dist. btn successive nodes or antinodes

$n \rightarrow$ Order of diffraction

$\lambda \rightarrow$ Wavelength of monochromatic light.

$\theta \rightarrow$ Angle of diffraction.

Let, λ_m be the Wavelength of ultrasonic waves in liquid medium, then $2d = \lambda_m$,

$$d = \frac{\lambda_m}{2}$$

Ultrasonic Testing :

Ultrasonic Testing is one of the most widely used non-destructive methods. It uses high frequency ultrasonic waves for testing of materials.

Ultrasonic testing is used to detect the flaws and thickness measurements and is commonly used in Industries.

There are three basic ultrasonic testing systems. They are (i) Pulse Echo System (or) Reflection System
(ii) Transmission System
(iii) Resonance System.

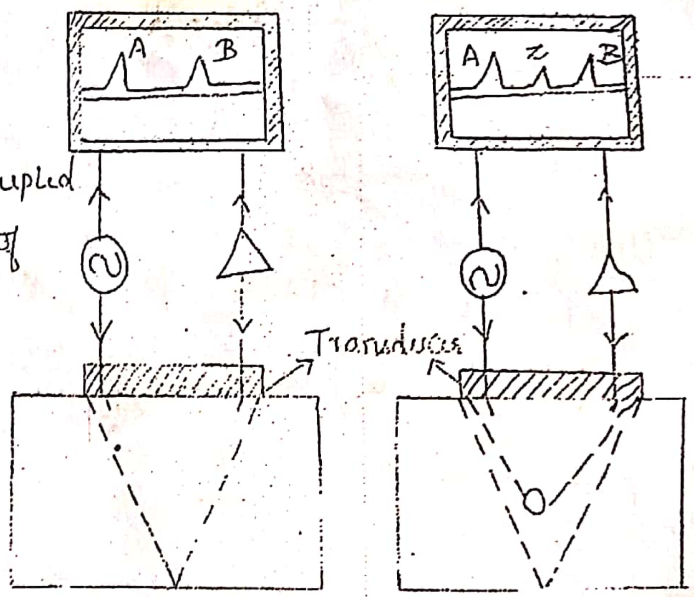
Pulse Echo (or) Reflection System : Ultrasonic Flaw detector.

Principle : 1. Whenever there is a change in medium ultrasonic waves will be reflected.
2. From the reflected waves, its flaws are identified.

Description :

- It consists of a Piezo electric transducer coupled to the upper surface of specimen without any airgap between them.

A Pulse generator and amplifier is connected between CRO and transducer.



(14)

Ultrasonic Scanning Displays:

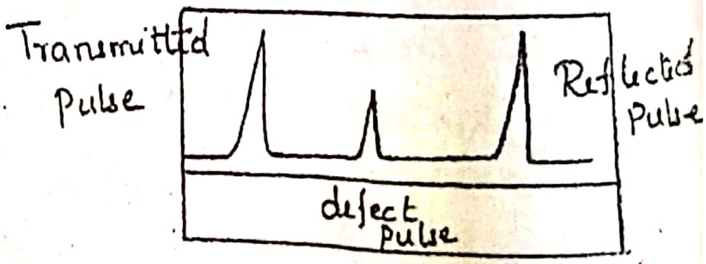
There are different ways of scanning the specimen by the ultrasonic transducer to get the detailed information about the specimen. The scanning displays are classified into,

(i) A- Scan (ii) B- Scan (iii) C- Scan.

A- Scan :- Amplitude Modulated Scan.

* A- Scan display gives only one dimensional information about the specimen.
* A single transducer is used to transmit and receive pulses from the specimen.
* Echo signals are applied to Y-plates and time base voltage is applied to X-plates of CRO.
* X-axis represents the time taken by the ultrasonic waves to travel from the transmitter to specimen and from specimen to receiver.
* Y-axis represents the amplitude of echos.

Reflected echos are displayed as vertical spikes. The height of the spikes corresponds to the strength of echo, and the position of spikes gives the depth of flaw from the transducer.



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Unit - 5.

The Propagation of light and Geometric Optics

Fermat's Principle

Light travels in a Straight line in a homogeneous medium. This statement can be explained by Symmetry of space. ie When a light Passing through a homogeneous medium in str. line (means all directions are same), if it wants to bend, where it will turn? If the medium is same, it cannot bend, but it must take the Path of a straight line only.

ie Light goes from a Point A to Point B in a straight line A ——→—— B.

This aspect was explained by Fermat and he stated ~~that~~ the Principle of least time as,

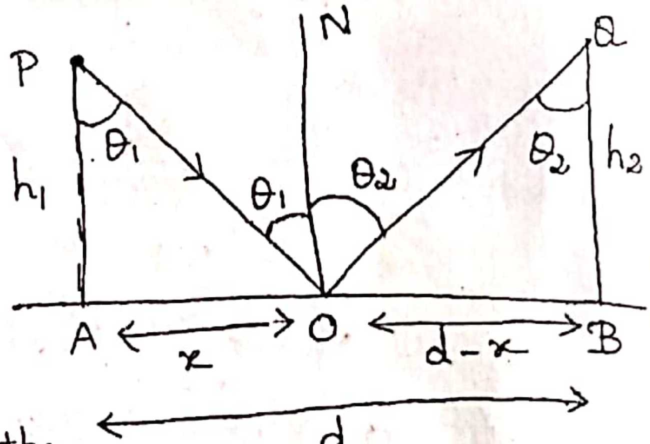
"Light has taken a Path, which takes least time to reach from ~~Point~~ one given Point to another Point".

The fundamental laws of rectilinear Propagation, reflection and refraction can be derived and Proved by this Fermat Principle, of least time.

(i) Rectilinear Propagation of Light :

The timetaken by a ray of light along a straight line is minimum as Compared to Curved path, be cause a straight line is a Path of least distance between two Points.

(ii) Laws of Reflection :



Consider a reflecting Surface AB, A light from the source P is incident at a Point O on the reflecting surface and is reflected at a Point Let N be the normal to the incident and reflected ray. Thus, θ_1 is the angle of incidence and θ_2 is the angle of reflection. As per the law of reflection, $\theta_1 = \theta_2$. This Can be Proved from Fermat's Principle.

Let OA = x, AB = d and so ~~OB~~ OB = $(d-x)$ and V be the Velocity of light.

∴ Time taken along the Path AOB is,

$$t = \frac{PO}{V} + \frac{OQ}{V}$$

$$t = \frac{\sqrt{h_1^2 + x^2}}{V} + \frac{\sqrt{h_2^2 + (d-x)^2}}{V}$$

According to Fermat Principle, the total time taken by the light should be either maximum or minimum. $\therefore \frac{dt}{dx} = 0$.

$$\frac{dt}{dx} = \frac{1}{V}\left[\frac{1}{2} \cdot \frac{2x}{\sqrt{h_1^2+x^2}} + \frac{1}{2} \cdot \frac{2(d-x)(-1)}{\sqrt{h_2^2+(d-x)^2}}\right]$$

$$\frac{dt}{dx} = \frac{1}{V}\left[\frac{x}{\sqrt{h_1^2+x^2}} - \frac{d-x}{\sqrt{h_2^2+(d-x)^2}}\right]$$

Let $\sin\theta_1 = \frac{x}{\sqrt{h_1^2+x^2}}$, $\sin\theta_2 = \frac{d-x}{\sqrt{h_2^2+(d-x)^2}}$

Let $\frac{dt}{dx} = 0$, $\therefore \frac{1}{V}\left[\sin\theta_1 - \sin\theta_2\right] = 0$

$$\sin\theta_1 = \sin\theta_2$$

$$\theta_1 = \theta_2.$$

Hence Proved, that angle of incident ray should be equal to the reflected ray.

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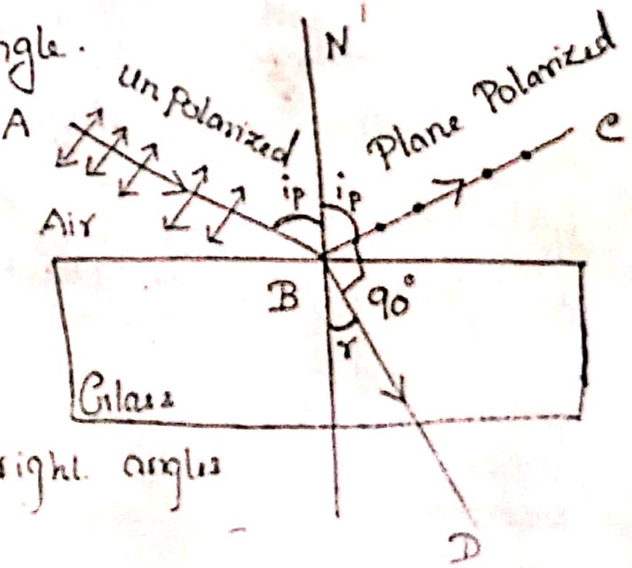
Brewster's Law! 36

[In 1811, Brewster Performed a number of experiments to study the Polarization of light by reflection at the surface of different media.

He observed that, Ordinary light is Completely Polarized, when it get reflected from the transparent medium at a Particular angle called the angle of Polarization.]

Consider a beam of unpolarized light AB, incident at an angle equal to the Polarizing angle on the glass surface. A Part of the light is reflected along BC and the other Part is refracted along BD. The reflected beam is Completely Plane Polarized.

It has been observed experimentally that, the reflected and refracted rays are at right angles to each other, when the light is incident at Polarizing angle.



$$i_p + 90^\circ + r = 180^\circ$$

$$r = 180^\circ - 90^\circ - i_p$$

$$r = 90^\circ - i_p$$

∴ The reflected and refracted rays are at right angles to each other

From Snell's law,

$$\frac{\sin i_p}{\sin r} = \mu$$, refractive index of glass.

Subs 'r', $$\frac{\sin i_p}{\sin (90^\circ - i_p)} = \mu$$

$$\frac{\sin i_p}{\cos i_p} = \mu$$

$$\boxed{\tan i_p = \mu}$$

Thus, Proves that the tangent of angle of Polarizing is numerically equal to the refractive index of the medium.

13(b) **Total Internal Reflection.**

The Phenomenon of total internal reflection takes place when it satisfies the following Conditions

1. Light should travel from denser medium to rarer medium.
2. The angle of incidence inside the denser medium should be greater than the Critical angle.

Let XY be a Plane surface which seperates a rarer medium (air) and a denser medium.

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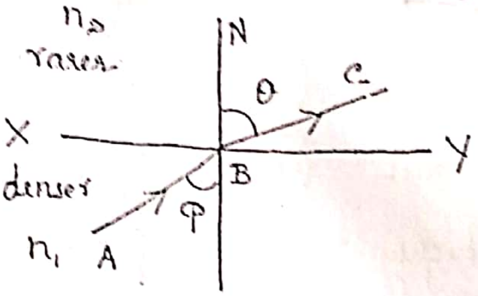
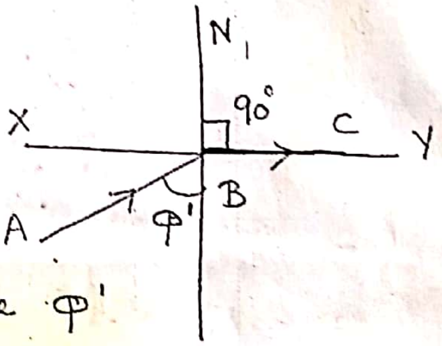
(i) Let AB be the incident ray which passes from denser to rarer medium. Bc be the reflected ray which is away from the normal, making an angle of refraction θ.



(ii) When the angle of incidence φ increases to φ' then the refracted ray BC moves away and falls on the interface between rarer and denser medium. In this case, the angle of refraction is 90°, called as critical angle (φ_c).



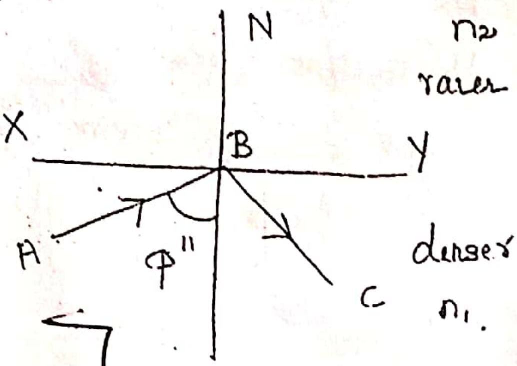
(iii) When the angle of incidence φ' increases to φ'', then the ray is totally reflected back into the denser medium itself. Hence the angle of ~~refraction~~ incidence should be greater than the critical angle (φ_c).

From Snell's Law,

$$n_1 \sin \varphi_c = n_2 \sin 90^\circ$$

$$\sin \varphi_c = \frac{n_2}{n_1}$$

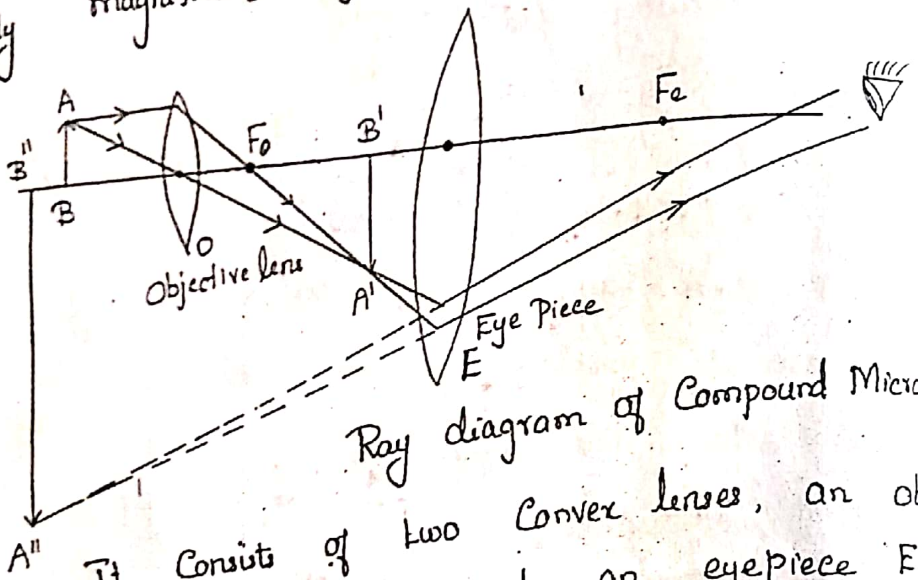
$$\boxed{\varphi_c \leq \sin^{-1}\left(\frac{n_2}{n_1}\right)}$$



Q. Optical Instruments

Compound Microscope :

A Compound microscope is an optical instrument Consisting of two Convex lenses of short focal lengths which is used for observing the highly magnified images of tiny objects.



Ray diagram of Compound Microscope.

It Consists of two Convex lenses, an object lens O of small aperture and an eyepiece E of large aperture. The lens which is Placed towards the object is Called objective lens, while the lens which is towards our eye is Called eyepiece. Although the focal length of two lenses are short the objective lens focal length is little shorter than the focal length of eyepiece, This is because, it may receive more light rays from the object and forms a bright image.

Fraunhofer Diffraction:

The bending of waves around the edges of an obstacle is called diffraction. In the fraunhofer diffraction, the source and the screen are at infinite distances from the obstacle producing diffraction. Hence, the wavefront undergoing diffraction is plane.

Fraunhofer diffraction at a Single Slit:

Consider a plane wavefront from a monochromatic source of light, having wavelength λ, incident on the slit AB.

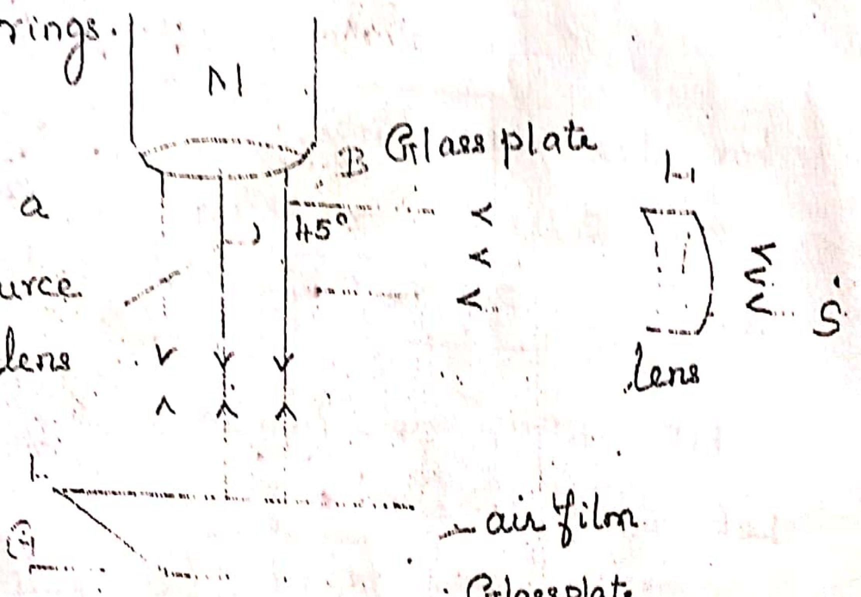
According to Huygen's Principle, every point on the plane wave front acts as a source of secondary wavelets. The spreading wavelets are focused by a convex lens L on a screen XY.

Interference of Waves by Amplitude Splitting -

Newtons Rings.

When a Plano Convex lens with of long focal length is placed on a plane glass plate, then a thin air layer is formed between lower surface of a lens and the upper surface of the plate. If the radius of curvature of plano convex lens is much greater than a distance 'r' and is viewed with monochromatic light, the pattern of dark and bright circular rings are produced in the air film. This is called Newtons rings.

Theory:



* A light from a monochromatic source S through the lens L1 falls on the glass plate B, at 45°.

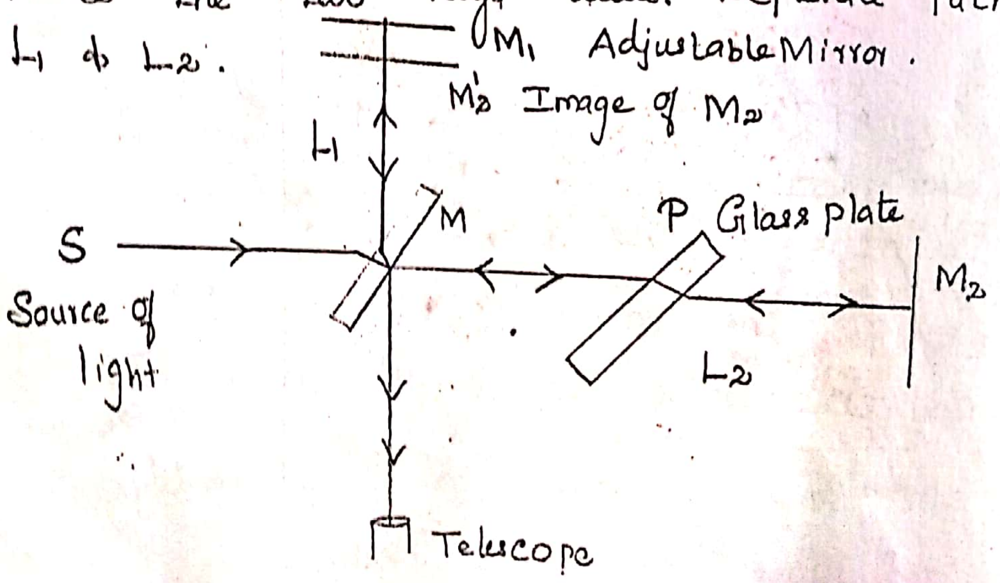
* The glass plate B reflects a part of the incident light towards the lens L and glass plate G.

14(b)

Michealson's Interferometer.

Instruments based on the Principle of interference of light are known as Interferometers. Michelson designed an interferometer to determine the wavelength of light.

* A ray of light from a monochromatic source is made to fall on the mirror M, which acts as a beam splitter, which is inclined at 45°.
* The beam Splitter M, will split ~~half~~ the light into two rays, one half ~~is~~ transmits the incident light and reflects the rest.
* The reflected ray from M, reflects Vertically upward towards the mirror M_1, and the transmitted ray from M, transmits horizontally ~~to~~ towards the mirror M_2.
* Hence the two rays travel seperate Paths L_1 & L_2.



Let AB be an object, to be magnified is placed in front of O, just beyond F_o. Now, the objective lens O forms a real, inverted and enlarged image A'B' of the object.

Now A'B' acts as an object for the eye piece E, It forms a final Virtual, inverted and highly magnified image A''B''. The eye piece is adjusted such that A'B' lies between the optic centre of E and Fe.

Magnification:

The magnification of Compound microscope is given by,

$$m = \frac{D}{F_o} \times \frac{L}{F_e}.$$

where D - least distance of distinct Vision.

L - length of the microscope tube.

f_o - Focal length of Objective lens

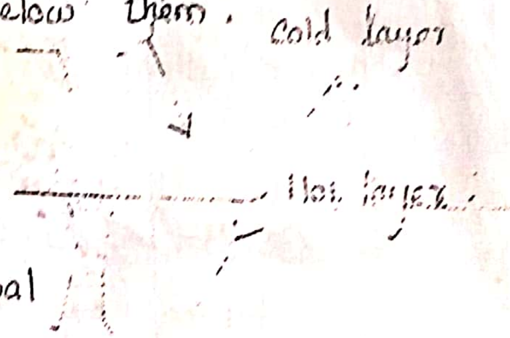
Fe - Focal length of Eye Piece.

13(a)

Mirage Effect

Mirage is an optical illusion caused due to total internal reflection of light in sandy deserts or in some extended surface like a black tarred road in very hot weather.

In hot summer day, sandy land becomes very hot during the day time. The air in contact with the ground becomes hot. So the refractive index becomes less and density is reduced whereas the density of air at higher level remains unaffected. Therefore, the layers of air near the ground are warmer than the air at the upper level. Thus the successive upper layers are denser than those below them.

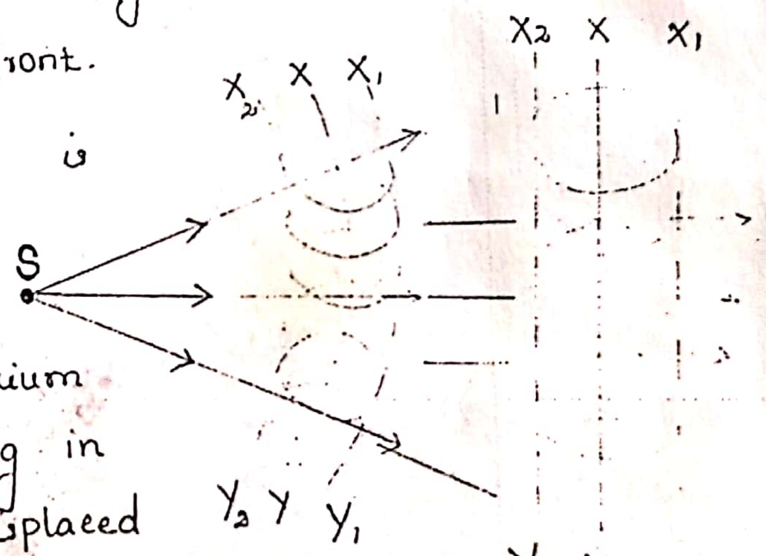


When the ray of light from the top of a tree travels from a denser to a rarer layer it bends away from a normal and thereby at a stage the angle of incidence become greater than the critical angle, the rays suffer total internal reflection and reach the eye of the observer. The observer sees an inverted image of the tree and conclude that there is water near the tree. Thus, it gives an optical illusion.

Unit - IV Wave Optics.

Huygen's Principle

According to Huygens, a source of light sends out waves in all directions, through a hypothetical medium called ether. Let S be the source of light sending light energy in the form of waves in all directions. After any given interval of time 't', all the particles on the surface of the medium will be vibrating in phase, and is shown in figure. ie XY is called the primary wavefront.



XY - Primary wavefront
X_1Y_1 - Secondary " front

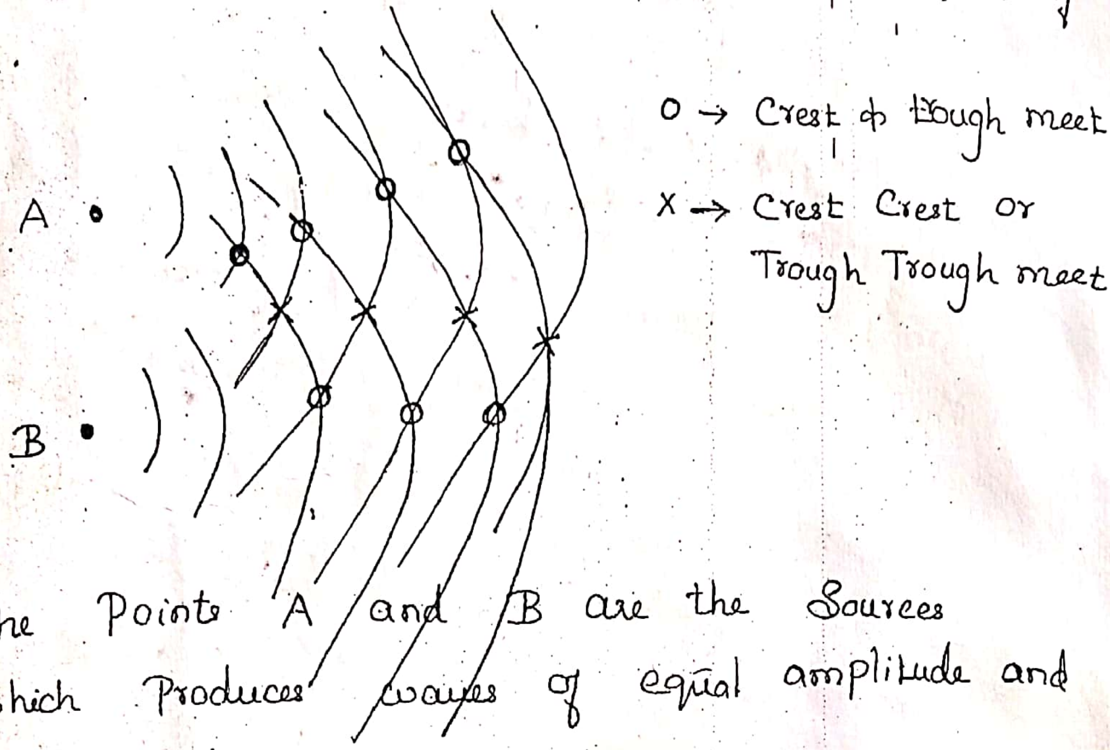
A Wavefront is defined as the locus of all the points of the medium which are vibrating in phase and are displaced at the same time.

(i) If the distance of the source S is small, the wave front is spherical.

(ii) If the distance of the source S is large, the wavefront is plane.

Interference of light Wave

The Phenomenon of interference of light is due to the Superposition of two waves. Consider the waves Produced on the surface of water.



* The Points A and B are the Sources which Produces waves of equal amplitude and Constant Phase.

* The Points shown by Circles 'o' will have minimum displacement because the crest of one wave will fall on the trough of other wave, and so the resultant displacement is zero.

* The Points shown by crosses 'x' will have maximum displacement because the crest of one wave will Combine with the Crest of other or trough will Combine with the trough of

19

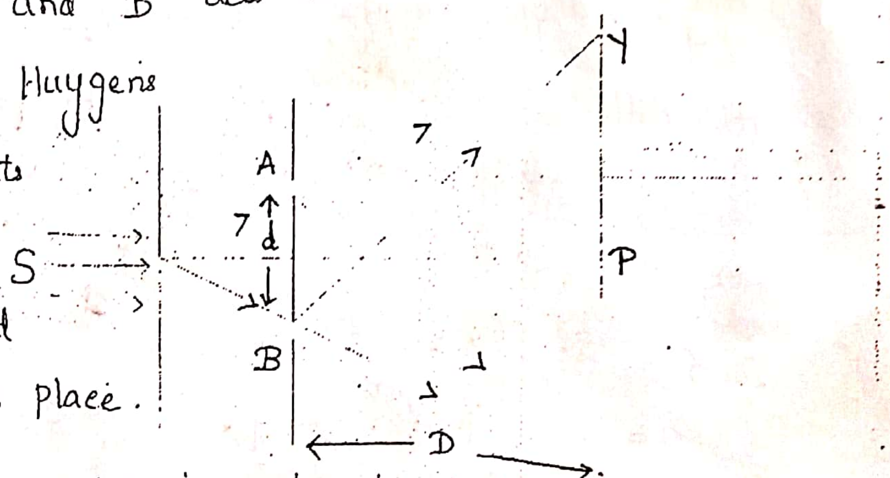
③

Interference of Waves by Wavefront Splitting - Young's double Slit Experiment.

The Phenomenon of interference was first observed and demonstrated by Thomas Young in 1801.

A monochromatic source of light from a narrow slit 'S' is allowed to fall on two narrow slits A and B placed very close to each other. The width of each slit is about 0.03 mm and they are at the distance of 0.3 mm apart. Since A and B are equidistant from S, light waves from S reaches in phase and so A and B acts as a Coherent Sources.

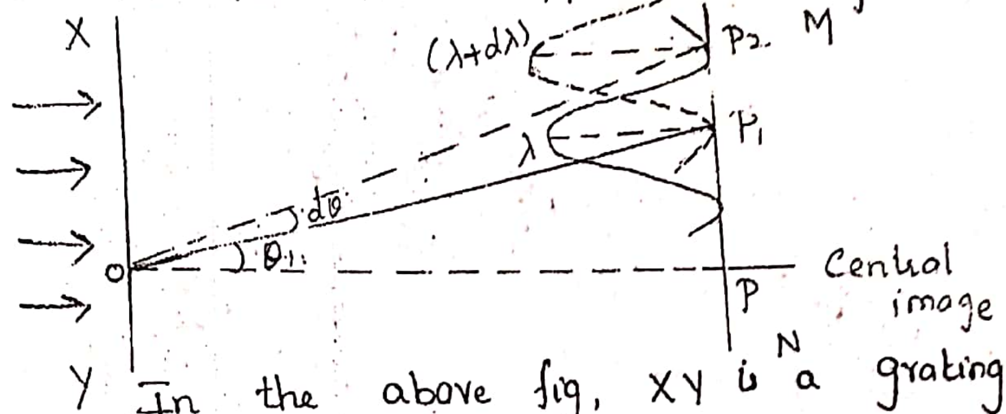
According to Huygens Principle, Wavelets from A and B Spread out and overlapping takes place.



When a Screen XY is placed at a distance of 1m from AB, alternate bright and dark fringes appears on the screen. These are called interference fringes or bands.

Resolving Power of Plane Diffraction Grating.

The resolving Power of a grating is defined as the ratio of the wavelength of any spectral line to the difference in wavelength between this line and a neighbouring line such that two-line appear to be just resolved.



In the above fig, XY is a grating element and MN is the field of view of the telescope. P_1 is the n^{th} Primary maximum of a spectral line of wavelength λ at an angle of diffraction θ. P_2 is the n^{th} Primary maximum of a second spectral line of wavelength $\lambda + d\lambda$ at an angle $\theta + d\theta$. P_1 and P_2 are the spectral lines in the n^{th} order.

The direction of n^{th} Primary maximum for a wavelength λ is,

$$(a+b) \sin \theta = n\lambda .$$

The direction of n^{th} Primary maximum for a wavelength $(\lambda + d\lambda)$ is,

$$(a+b)\sin(\theta + d\theta) = n(\lambda + d\lambda) \quad \text{---(2)}$$

The two lines will appear just resolved if the angle of diffraction $(\theta + d\theta)$ corresponds to the direction of first sec. minimum after n^{th} Primary maximum at P_1. This is possible, if the extra Path difference introduced is λ/N, where N is the total number of lines of the grating surface.

$$\therefore (a+b)\sin(\theta + d\theta) = n\lambda + \lambda/N \quad \text{--- (3)}$$

Equating (2) & (3),

$$n(\lambda + d\lambda) = n\lambda + \lambda/N.$$

$$n\lambda + nd\lambda = n\lambda + \lambda/N.$$

$$nd\lambda = \lambda/N$$

$$nN = \lambda/d\lambda.$$

Thus, $\frac{\lambda}{d\lambda} = nN$, measures the resolving Power of a grating.

Resolving Power of Plane Diffraction Grating.

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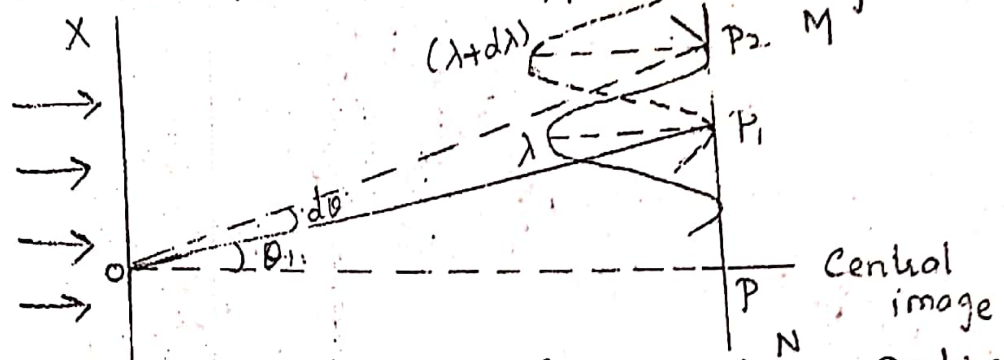

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(13)

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$$n\lambda + n d\lambda = n\lambda + \lambda/N.$$

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Thus, $\frac{\lambda}{d\lambda} = nN$, measures the resolving Power of a grating.

UNIT-5 Photonics

①

[PHOTONICS, is derived from the word Photon, which is the smallest unit of light. According to Quantum theory, light Consist of Photons. Light Sources used in Photonics include, LEDs, Diodes, and Lasers.]

LASER stands for Light Amplification by Stimulated Emission of Radiation. Laser is a device, which Produces intense, monochromatic and Coherent beam of light.

Characteristics of LASER.

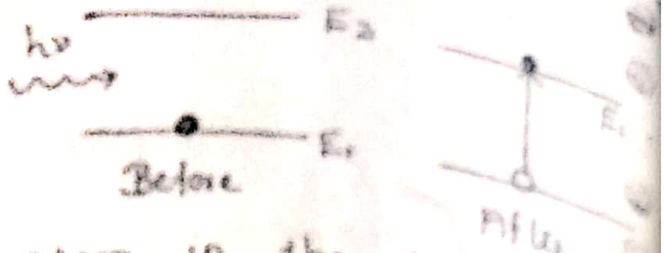
* High degree of coherence
* High Intensity
* High directionality
* High Monochromaticity.]

Consider an atom having two Energy levels E_1 and E_2. When the atom is exposed to a Stream of Photons, the following Process takes place.

* Stimulated absorption
* Spontaneous Emission
* Stimulated Emission.

Stimulated absorption:

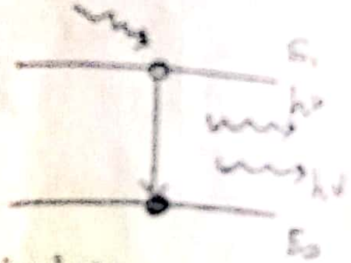
An atom or molecule in the ground state E_1 Can absorb a photon of energy $h\nu$ and go to the higher state E_2. This Process is known as Stimulated absorption.



Spontaneous Emission:

The atom in the excited state E_2 make a transition to the lower energy state E_1 by emitting a photon of Energy hν without any external triggering, is called Spontaneous Emission.

Stimulated Emission:



The atom in the excited state E_2 make a transition to the lower energy state E_1 by stimulating (triggering) an atom in the excited state. This transition emits two photons, having energy hν is called Stimulated Emission.

The Photons emitted due to Stimulated emission has the same freq and Phase as the incident Photon.

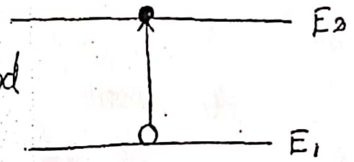
This is the basic Concept of Laser. It is the Process of Stimulated Emission which is dominant in laser light source.

②

Einstein's Coefficients A and B.

Consider a two level energy system E_1 and E_2. Let N_1 and N_2 be the number of atoms in the ground state and excited state E_2.

* **Stimulated absorption:**



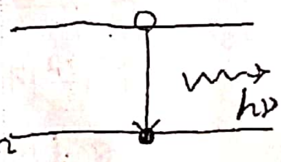
The atoms in the ground state E_1 are excited to the higher energy level E_2 due to absorption of Photons having energy $h\nu$. This Process is called stimulated absorption. This transition is called upward transition.

The number of transitions occurring per unit Volume per Second depends upon, Number of atoms (N_1) in E_1 and density (Q) of incident radiation.

$$N_{ab} = N_1 B_{12} Q \text{ ——— } ①$$

Where B_{12} is Einstein's coeff of absorption or Probability of absorption.

* **Spontaneous Emission:**



The atoms in the excited state E_2 make spontaneous transition to the lower energy state E_1 without external force. This transition is called downward transition.

The number of transitions occuring per unit time per Volume depends upon number of atoms (N_2) in E_2.

Active Medium :

A medium in which population inversion is achieved is called active medium.

Meta Stable State :

It is the life time of atoms in the excited state. The atoms excited to the meta stable state should remain in that state for an time of 10^{-6} to 10^{-3} sec.

Pumping Action :

The Process to achieve population inversion in the medium is called Pumping action.

Conditions for Population Inversion :

* There must be atleast two energy levels.
* There must be a source to supply energy to the medium.
* The atoms must be continuously raised to the excited state.

Methods for Achieving Population Inversion :

- Optical Pumping
- Electrical discharge Method
- Direct Conversion
- Inelastic atom-atom Collision
- Chemical reaction.

Types of Lasers:

Lasers are classified into five major categories based on the type of active medium. They are:

1. Solid State Laser — Ruby laser, Nd-YAG Laser
2. Gas laser — He-Ne laser, CO_2 laser
3. Liquid laser — $SeOCl_2$ laser, Europium chelate laser
4. Semi Conductor laser — GaAs laser, InP laser
5. Chemical & dye laser — HF_2 chemical laser, Coumarine dye laser

Component of Laser:

The essential component of Laser are.

(i) Active Medium (ii) Pumping Source (iii) Optical Resonator.

15 (b)

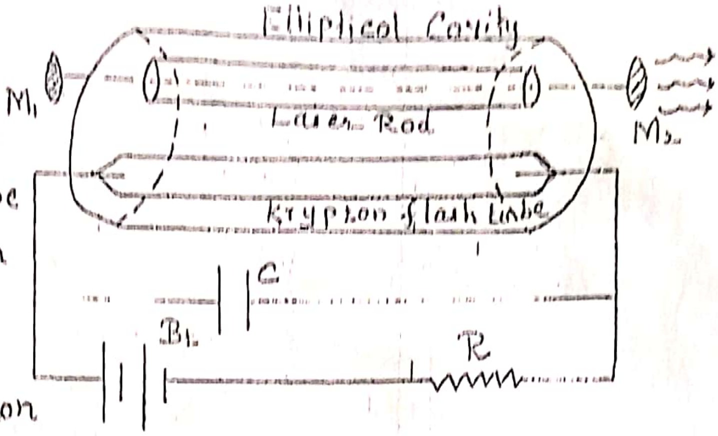
Nd - YAG Laser

Nd - YAG laser is a four level solid state laser. YAG stands for Yttrium Aluminium Garnet and Nd for Neodymium. Here Y^{3+} ions in the Crystal are replaced by Nd^{3+} ions.

Principle:

- The active medium is Nd-YAG Crystal in the form of a rod.
- Nd^{3+} ions are raised to excited state by Krypton flash tube
- Transition takes place and laser beam is emitted.

Construction :



* Nd - YAG Crystal acts as a laser rod and Krypton flash tube are placed inside an elliptical cavity.
* Light from the Krypton flash tube is effectively focussed on the laser rod in order to achieve population inversion.
* This flash tube is controlled by a capacitor.
* The end faces of a laser rod are well polished and silvered.
* This polished laser rod and two mirrors M_1 and M_2 form the optical resonator.
* The mirror M_1 is fully reflecting and M_2 is partially reflecting.

Working:

- The light from the flash light is allowed to fall on the laser rod.
- This light excites Nd^{3+} ions from the ground state to higher energy states E_3 & E
- Some Nd^{3+} ions in E_0 absorbs 0.80 μm wavelength of energy radiation and move to an energy state E_3.
- Some Nd^{3+} ions in E_0 absorbs 0.73 μm wavelength of radiation and move to E_4.

Applications :

1. They can be used to transmit signals over long distances.
2. They are used in resistor trimming.
3. They are used in engineering applications like welding, drilling etc.
4. They are used in medical applications such as dental surgery, endoscopy, Urology etc.

CO_2 Laser :

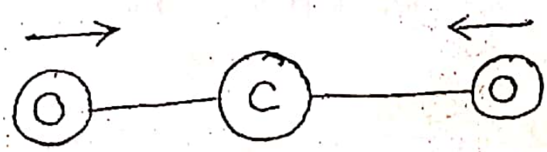
CO_2 is the first molecular Laser which was developed by Prof. C.K.N. Patel. In this laser, the laser Oscillations are achieved by the transitions between Vibrational and rotational levels of the molecules.

Vibrational Modes of CO_2 :

There are three modes of Vibration. They are,
1. Symmetric Stretching Mode
2. Bending mode.
3. Assymmetric Stretching mode.

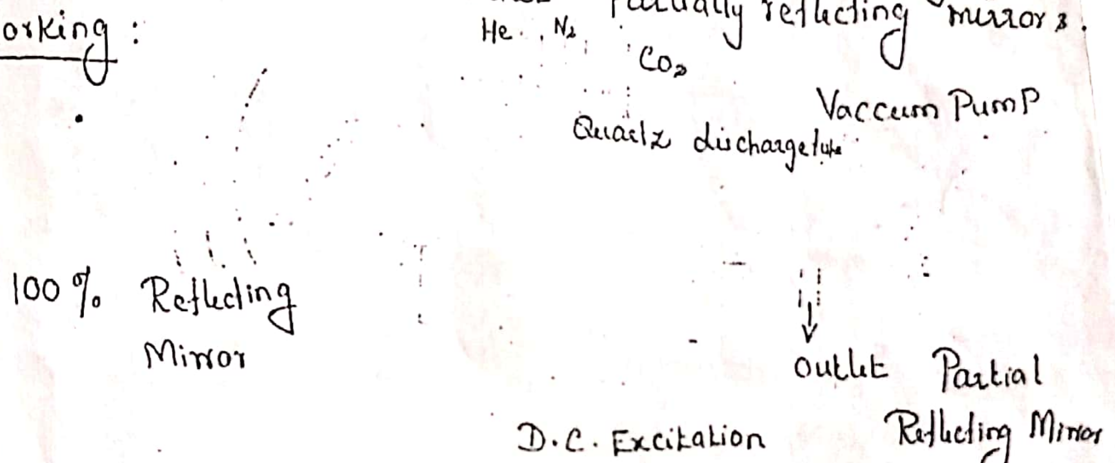
* Symmetric Stretching Mode :

The Carbon atom is fixed at the Centre,



* The ends of the discharge tube are fitted with Nacl Brewster window, so that the laser light Produced will be Polarized.
* The discharge tube is Connected to a DC Power supply.
* The Optical resonator is formed with two Concave mirrors, one fully reflecting mirror and other Partially reflecting mirrors.

Working:



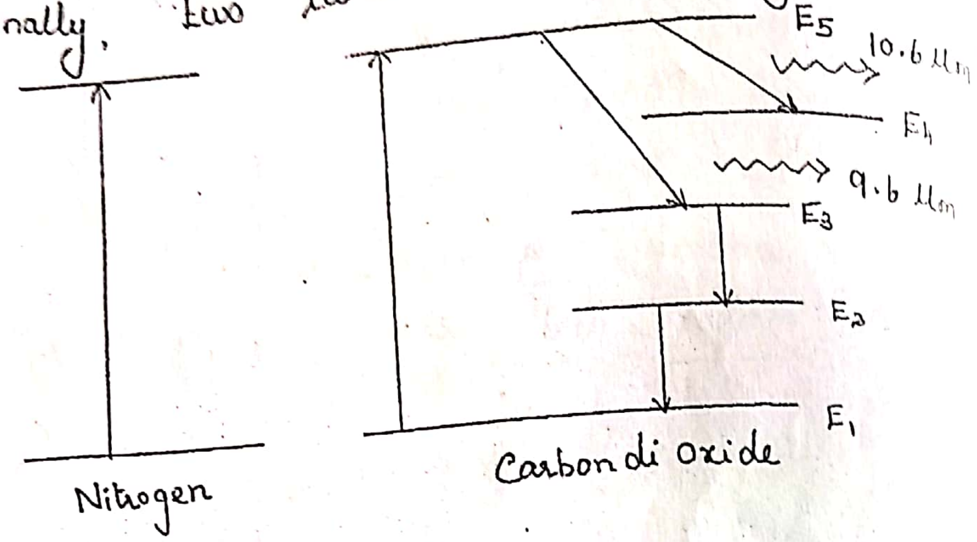
- When the power Supply is switched on, the excited electrons Collide with the nitrogen molecules and raised to the excited state.

$$N_2 + e \rightarrow N_2^* + e$$

- The nitrogen molecules N_2^* in the excited state collides with CO_2 atoms in the ground state and raised to the excited state.

$N_2^* + CO_2 \rightarrow CO_2^* + N_2$.

- Since the excited level of Nitrogen is very close to the energy state E_5, the Population inversion is achieved in the Energy state E_5.
- Finally, two laser transitions may takes place.



(i) <u>$E_5 - E_4$ Transition</u> :

This transition may Produce a laser beam of wavelength 10.6 µm.

(ii) <u>$E_5 - E_3$ Transition</u>:

This transition may Produce a laser beam of wavelength 9.6 µm.

The Helium gas is used to Conduct the heat away from quartz tube. Thus, the output is Continuous and Power is of 10 KW, is emitted.

Advantages :

1. The design is simple and efficiency is high.
2. It can produce high output power.

Disadvantages :

1. This laser light may cause eye damage.
2. Output power depends on operating temp.

Applications :

1. It can be used in welding, drilling, cutting and soldering.
2. It can be used in laser remote sensing.
3. It can be used in the treatment of liver, lungs, micro surgery, bloodless operations. etc.

Semi Conductor Lasers :

A Semiconductor laser is the most compact laser, which is fabricated by a p-n junction device. It is also called Injection laser.

There are two types of Semi Conductor laser, namely, 1. Homo junction SemiConductor laser
2. Hetero junction SemiConductor laser.

When a p-n junction is made up of same material, it is known as homo junction Semi Conductor laser, Example : GaAs.

When a P-n junction is made of different materials, it is known as hetero junction Semiconductor laser.

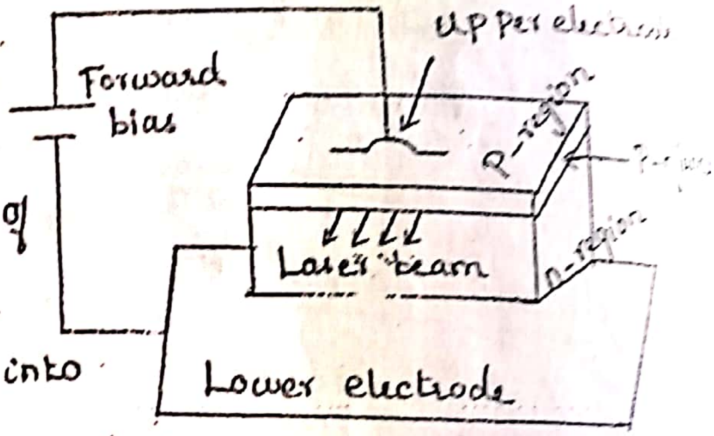
Example: GaAs and Ga-Al-As.

Homo-Junction Semi Conductor Laser:

Principle:

When a diode is forward biased, the electrons and holes will recombine within the junction and the energy is released in the form of light Photons. This Photons will stimulate other electrons and the laser light is Produced.

Construction:



- It Consists of a Single crystal of Gallium Arsenide which is cut into a platelet with a thickness of 0.5 mm.
- The Platelet Consists of heavily doped n-region and P-region.
- The forward bias is applied to the diode through electrodes.
- The end faces of P-n junction are well polished and acts as an optical resonator

BHARATH INSTITUTE OF SCIENCE AND TECHNOLOGY
Department of Physics

INTERNAL ASSESSMENT - 1

Waves and Optics – U18BSPH101

Date : 09.09.2019

Academic Year / Semester : 2019-2020/ODD Duration : 1 hour 30 mins

Q.No	PART A (6 x 2 = 12) ANSWER ALL QUESTIONS	Weightage	CO	Bloom's Level
1	Classify longitudinal and transverse waves?	2	CO1	R
2	Illustrate the term Wavelength and Amplitude.	2	CO1	R
3	List out the conditions necessary for interference?	2	CO1	R
4	Summarize the properties of ultrasonic waves.	2	CO2	U
5	Illustrate the term acoustic grating?	2	CO2	U
6	What is piezoelectric effect?	2	CO2	U
	PART B (3 x 6 = 12) ANSWER ANY THREE QUESTIONS			
7(a) 7(b)	Outline the properties of stationary waves? (OR) Give brief explanation about the harmonics.	6	CO1	R
8(a) 8(b)	Justify the phenomenon of interference of light in practical applications. (OR) Explain various methods for the detection of Ultrasonic Waves.	6	CO6	A
9(a) 9(b)	Describe the industrial applications of ultrasonic waves. (OR) Explain sonogram with a neat diagram.	6	CO2	U
	PART C (2 x 10 = 20) ANSWER ANY TWO QUESTIONS			
10(a) 10(b)	Derive the wave equation of a longitudinal wave. (OR) Explain in detail about superposition of waves.	10	CO2	R
11(a) 11(b)	Explain the phenomenon of Piezoelectric effect. How high frequency sound waves are produced using Piezoelectric oscillator? (OR) Explain how the velocity of ultrasonic wave is determined using acoustic grating.	10	CO3	U

CO	Weightage
CO1	-
CO2	-
CO3	22
CO4	22
CO5	-
CO6	06
Total	50

Prepared by	Dr. C. Rathika Thaya Kumari	Signature
Verified by	Dr. R. Velavan HOD	Signature

Bharath Institute of Higher Education and Research
First Year B. Tech – Semester I, September 2019
Internal Assessment I
Waves and Optics- U18BSPH101 (Common to all branches)

Part A (10x2=20)

Answer all Questions

1. Longitudinal waves & Transverse waves (2 marks)

Longitudinal	Transverse
The medium moves in the same direction of the wave	The medium is moving perpendicular to the direction of wave
It acts in one dimension	It acts in two dimension
This wave can be produced in any medium such as gas, liquid or solid	This wave can be produced in solid and liquid's surface

2. Time period & Wavelength (2 Marks)

The distance between two consecutive compressions or two consecutive rarefactions is known as the wavelength. Its SI unit is metre (m). The ***time*** it takes to complete a ***cycle*** is the ***period***.

3. Conditions for interference (2 Marks)

4. Properties of ultrasonics: (2 Marks)
   - The ultrasonic waves cannot travel through vacuum.
   - The ultrasonic waves are high frequency sound waves with smaller wavelength.

5. Acoustic Grating: (2 Marks)

When ultrasonic waves are passed through a liquid, the density of the liquid varies by layer due to the variation in pressure and hence the liquid will act as a diffraction grating, so called acoustic grating. Under this condition, when a monochromatic source of light is passed through the acoustical grating, the light gets diffracted.

6. Piezoelectric effect (2 Marks)

Part B (3x6=12)

7(a). Characteristics of Wave motion (6 Marks)

- In wave motion, the disturbance travels through the medium due to repeated periodic oscillations of the particles of the medium about their mean position (or) Equilibrium position.
- Energy and momentum are transferred from one point to another without any actual transfer of the particles of the medium.
- There is a regular phase difference between the particles of the medium because each particle receives disturbance little later than its preceding particle.
- The velocity with which wave travels is different from the velocity of the particles with which they vibrate about their mean (or) equilibrium position.
- For a given medium the velocity of the wave motion remains constant, while the particle velocity changes continuously during its vibration about their equilibrium position.
- The velocity of the particle is maximum at the mean position and zeroes at the extreme position.

7(b). Harmonics (6 Marks)
Fundamental frequency
First over tone frequency
Second overtone frequency

8(a). Interference

Constructive interference: Constructive interference takes place when the crest of one wave falls on the crest of another wave such that the amplitude is maximum. These waves will have the same displacement and are in the same phase.

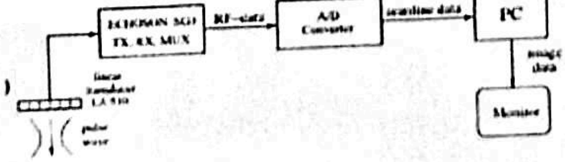
Destructive interference: In destructive interference the crest of one wave falls on the trough of another wave such that the amplitude is minimum. The displacement and phase of these waves are not the same.

8(b). Kundt's tube method (2 Marks)
Sensitive flame method (2 Marks)
Thermal detectors (2 Marks)

9(a) Applications of ultrasonics (6 Marks)
Any 6 points

9(b) Sonogram

Diagram (2 Marks)



Explanation (4 Marks)

Part C (2x10 = 20)

10(a). <u>Wave Equation of Longitudinal Waves</u> (6 Marks)

$$y(x,t) = y_0 cos[\omega(t - \frac{x}{c})]$$

10(b). Superposition of Waves (10 Marks)

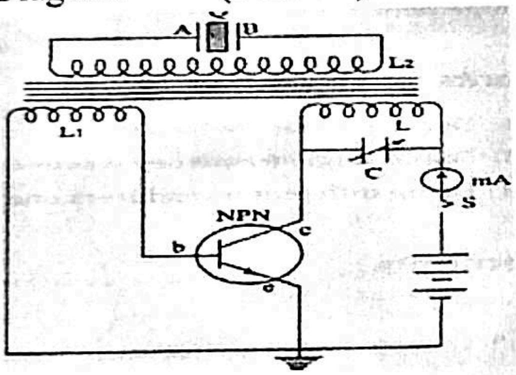
Explanation in detail

11(a) Piezo electric Generator

Principle (2 Marks)

When an alternating e.m.f is applied to the opposite faces of a quartz or tourmaline crystal it undergoes contraction and expansion alternatively in the perpendicular direction. This is known as inverse piezoelectric effect. This is made use of in the piezoelectric generator.

Diagram (2 Marks)

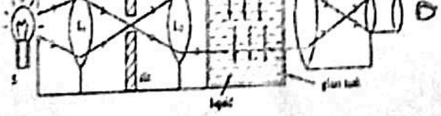


Construction (2 Marks)

Working (4 Marks)

11(b). Velocity determination using ultrasonics

Diagram (2 Marks)



Principle (2 Marks)

When ultrasonic waves travel through a transparent liquid, due to alternate compression and rarefaction, longitudinal stationery waves are produced. If monochromatic light is passed through the liquid perpendicular to these waves, the liquid behaves as diffraction grating. Such a grating is known as Acoustic Grating. Here the lines of compression and rareaction act as transparent light waves. It is used to find wavelength and velocity(v) of ultrasonic waves in the liquid.

Explanation (6 Marks)

Internal Assessment-I

45/50

Name: Adla pavan Reddy

Roll no: U19CS022

PART- A

1. Transverse Wave

A transverse wave is a wave in which particles of the medium moves in a direction perpendicular to the direction of propagation.

Transverse waves can exist on the surface of a liquid.

Longitudinal.

A longitudinal wave is a wave in which the particles of the medium moves in a direction parallel to the direction of propagation.

Longitudinal waves travel through the back of a fluid.

the

Properties of ultrasonic

* They are nothing but sound waves but with frequency higher than 20 kHz

* They are highly energetic

* Intense ultrasonic radiation has a disruptive effect in liquids by causing bubbles to be formed.

2 Wavelength and Amplitude

Wavelength → The distance b/w any two successive crests or throughs is called wavelength.

Amplitude → The maximum displacement in a waveform is known as amplitude

Interference :

When two waves pass simultaneouly through some point in a medium. then the resultant displacement at that point is the vector sum of the displacement due to two component waves. The superposition of two waves is known as Interference.

piezo electric effect :

When a mechanical stress is applied to on pair of opposite faces of a crystal. then equal and opposite charges are developed on the other pair of opposite faces of the crystal. This is known as piezo electric effect.

5. acoustic grating :

* When ultrasonic waves passes through a liquid, stationary waves are produced due to alternate compression and Rarefaction.

* Now, liquid behaves as a diffraction grating called acoustic grating.

* The region of compression act as a opaque medium and rarefaction act as a transparent medium.

PART - C

Piezo electric Oscillator:

Principle:

Inverse piezo electric effect is the principle behind the production of ultrasonics using piezo electric oscillator.

When an alternating voltage is applied to one pair of opposite faces of a Quartz crystal - crystal starts vibrating on the other pair of opposite faces of the Quartz crystal.

Resonance Condition:

When the frequency of alternating current is equal to the frequency of Quartz crystal resonance occurs

$$\frac{1}{2\pi\sqrt{L_1 C}} = \frac{P}{2l}\sqrt{\frac{E}{e}}$$

At resonance

Construction:

It Consists of primary and Secondary circuits

There are two coils L_1 and L_2 in

6

This current is transferred to the secondary circuit due to transformer action.

This current is fed to the plates A and B

Due to inverse piezo electric effect

Frequency of the oscillator circuit is adjusted by the capacitor C and when this frequency is equal to the vibrating crystal resonance occurs.

$$n = \frac{P}{2l}\sqrt{\frac{E}{\rho}}$$

n → frequency of quartz crystal

p → 1, 2, 3 for fundamental, first over tone and second over tone

E → young's modulus of the crystal

ρ → Density of the crystal.

Advantages

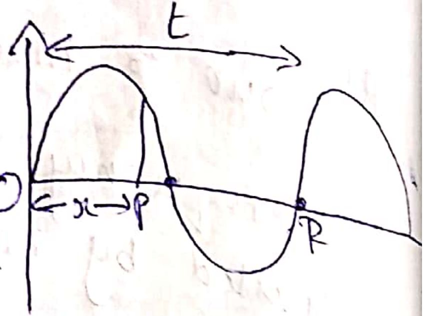
* More efficient than magnetostriction oscillator
* Can produce ultrasonic frequencies of 500 MHz

Disadvantage

* Cost is high
* Cutting and shaping of piezo electric crystal is complex

10 (a) Longitudinal Waves Equation.

~~Where~~ Wave equation of an obj gives the position of the object as a function of time.



Consider the harmonic motion of a particle in a medium.

As the oscillations are from point to point, the particle in the medium will be in different position at different times. Hence, the displacement of particle in a medium is represented as a function of space coordinates and time.

Thus, the displacement

$y = f(x,t) \longrightarrow (1)$

In case of a one dimensional wave along positive x-axis, the displacement is represented as a function of time, at position $x=0$

$\therefore y = f(t)$

Since, the oscillations are sinusoidal, we can represent the displacement as

$y = A \sin \omega t$

$y_u = A \sin 2\pi \nu t \quad \longrightarrow (2)$

The wave is travelling with a velocity v. Then, after time t, its moved through the distance, $x = vt$ $v = x/t$

$\therefore$ The displacement ; $y = f(x - vt)$ $\rightarrow$ (3)

We know $v = \nu\lambda$

$$\frac{x}{t} = \nu\lambda$$

$$\boxed{\frac{x}{\lambda t} = \nu} \rightarrow (4)$$

Hence eqn (2) can be written as

$$y = A \sin 2\pi (x/\lambda) \rightarrow (5)$$

This eqn (5), clearly shows that the wave is periodic.

Thus, the displacement at point P on a harmonic wave in terms of space and time as

$$y = A \sin \left[\frac{2\pi}{\lambda} (x - vt)\right] \rightarrow (6)$$

$$\therefore y = A \sin k (x - vt) \rightarrow (7)$$

Where $k = \frac{2\pi}{\lambda}$, is known as propagation constant (or) wave number.

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eqn (1) can be rewritten as

$y = A \sin(kx - wt)$ → (8)

eqn (8) represents the wave equation.

8+1 ✓

PART - B

7 a) properties of stationary wave

1. All the particles except those at nodes execute simple harmonic motion of the same period and different amplitudes about their mean position.

2. There is no transfer of energy in any direction, because the particles in the medium passes their the mean position twice during each vibration.

3. The points where the displacement is zero is called nodes and at maximum is called antinodes.

4. The distance b/w two consecutive nodes and antinodes is equal to λ/2, whereas the distance between a node and antinode is equal to λ/4

* Platinum wire is connected to MP Ultrasonics

* R_1, R_2 —> Resistance

* R_3 —> variable resistance

Galvanometer - check the blancing position of M.B

<u>Working</u>:

* Ultrasonic waves are allowed to pass Thro platinum wire.

* Nodes present in the waves - compre-ssion & rarefraction on pt wire.

* also produces heating & cooling effects on pt wires.

* due to change in T, R also changes - makes bridge - unbalanced condition

* At antinodes, no comp & rarefraction

So, no change in T & bridge -

* By noting the blancing position detect whether ultrasonic waves present (unblanced condns)

U19CS034

* PART-B *

(3x6=18M)

33/50

1. Applications of Ultrasonics in Industries.

→ Ultrasonic Welding :-

* In this type of Welding Ultrasonics ~~are~~ formed into the metals.

* Ultrasonics, melts the metallic nature of metals, which shows, fixing of nature.

* More over ultrasonics generates the melting power and generates again by fixing it in a major linkage.

→ Ultrasonic Soldering :-

* Ultrasonic are used in soldering process too.

* Ultrasonics makes the metals heated and shape in's the metals in a usefull manner, where there ultrasonics make a big role of managing the metals in household circuit purposes.

→ Ultrasonics are much needed usefull sound waves which are required for as much as possible. In many as we seen, melting, Welding, and Soldering process. Ultrasonic sound waves explains the importance of sound waves which are very being used in Industrial process.

As in Medical Work too, Ultrasonic sound waves terms to be used.

6

10A:- Sonogram :-

→ Sonogram is a useful devices, which helps to identify the internal structure of the body. It is equal X-rays. Where ultrasonic waves are send to known the radiations of internal body.

→ As in time of women pregnancy. This sonogram plays a major role. As it is required to find the moment the baby in the womb, where. As it is also useful to know the gender of the body.

→ Sonogram which is used sends a large (or) heavy amount of sound waves / like ultrasonic sound are entered into the body, where it can find the movements of the body.

→ These sonogram machine can also have the ability to known the joints thickness (or) recriptis in our body which will not be known by X-rays.

* There sonograms are much equal as X-rays where can known about bones and sonogrames can known about muscles internal structure.

Detection of Ultrasonics :-

* Ultrasonics can be detected by many well known sources.
* Ultrasonics are mainly produced by whistels, sound walls rubbing, Vibrating metals and many more..

→ But the main important resources of Ultrasonic are:-

(1) Magneto-striction sound waves

(2) Piezoelectric sound waves,

→ This type of welding ultrasonics are termed into the metals, Ultrasonics melts the metallic nature of metals, which shows, fixing of nature. Moreover, ultrasonics generates the melting power and generates again by fixing it in a major linkage.

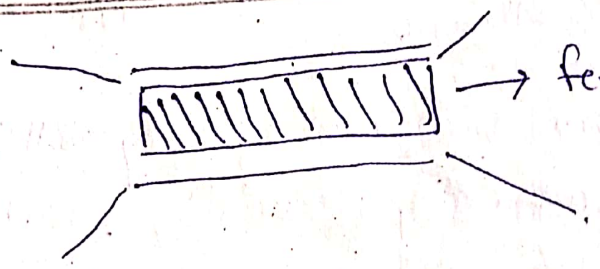
→ Ultrasonics are much needed as possible in many as we seen, which are required for as much many melting, soldering process. Ultrasonics, sound waves explains the importance of sound waves which are very being used in Industrial process. As in medical work too. Ultrasonic are used in wide range.

(5)

* PART-C * (2x10=20M)

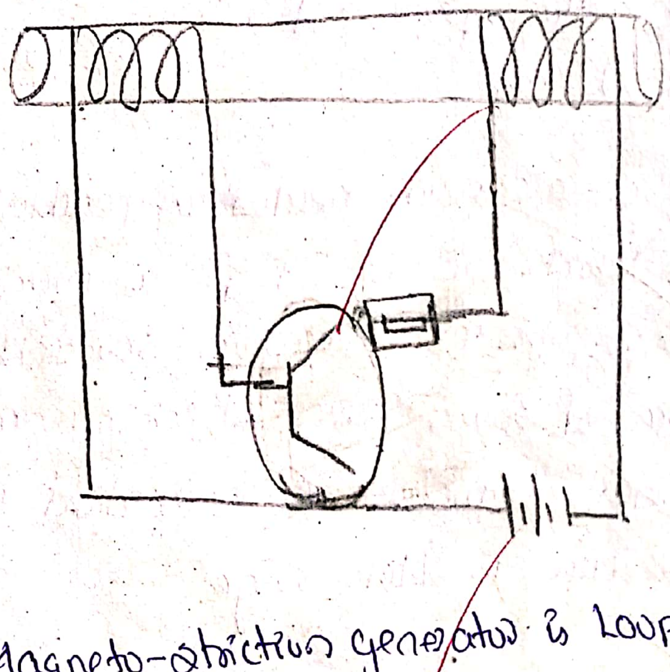
Magneto-striction Generator :-

* If the both the ferromagnetic power are suspended to each other.



→ Ultrasonics as measured due to Alternating magnetic mean which implies to the both contraction and Expansion of magnetic matrial. which is equal magnetic (or) applied magnetic range is called Magneto-striction Effect.

<u>Magneto-striction Generator</u>:-



→ Magneto-striction generator is Loop with a bundl of Lires as shown in fig. Where, a battery at the down, which makes sures of generating electricity in the Loop.

→ Where both the maximum range of Contraction and Exponsion are taking place to form a Loop.

→ There Magnostriction generator, where both the property of contraction level and Expansion level takes place, such at the maximum Expansion level. Magnostriction generator shows the defect, as an ideal range of Electricity.

→ Contraction levels also increases by an high range of intermediate. existance with a few. Electricity level. Where, h_1 and h_2. are individually increased by many unknown characteristics.

Acoustical grating:-

→ formation of sound waves, where, it makes a proper arrangement of existance layer by layer. which will shown an arrangement of colours with a range.

$$d\sin\theta = n\lambda$$

Where,

d = distance.

n = frequency /(or) Number.

λ = density.

→ As measured, speed of the sound wave in air is 3,800C. where it varies from water. As water as very different level of depth and nature, there velocity is also different, with acoustical grating.

→ These formation makes a very important measure the there wavelength various upto a given frequency in different medium

→ Medium decides the speed and wavelength of for frequency., where underneath, the speed (or) velocity of ultrasonics differe.

8

* THE END *

U19CS045

CSE

29½ / 50

Internal Assessment I

PART- C

Inverse piezo electric effect:

When potential difference or emf is applied on one pair of opposite faces of the quartz crystal, crystal starts vibrating on the other pair of opposite faces of the quartz crystal.

Piezo electric Oscillation:

Principle:

* Inverse piezo electric effect is the principle behind the production of ultrasonics using piezo electric Oscillation.

* when an alternating voltage is applied to one pair of opposite faces of a Quartz crystal - crystal starts vibrating on the other pair of opposite face of the Quartz crystal.

Resonance Condition:

when the frequency of alternating current is equal to the frequency of

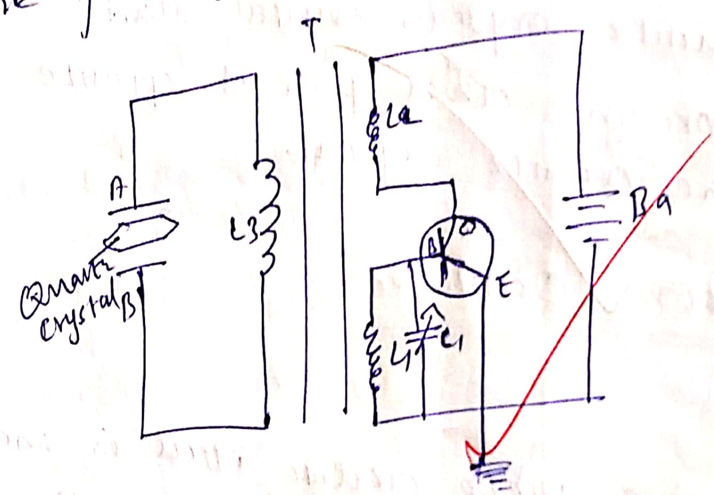
Crystals resonance Occurs

$$\frac{1}{2\pi\sqrt{LC}} = \frac{P}{2l}\sqrt{E/\rho}$$

Construction:

* It consists of primary and Secondary circuits

* These are two coils, L1 and L2 in the primary circuit;



* L1 is connected in parallel with capacitor

* L1 and C forms resonant circuit which is connected with the base of the transistor

* Capacitor C is used to vary the frequency of the oscillatory circuit.

* L2 is connected to the collector of the transmitted and it is inductively coupled to the secondary circuit.

* The other end of coil L2 is connected

a battery:

* secondary circuit consist of coil Ls

* Two metal plates are connected to the two ends of coil Ls

* when the battery is switched on, the oscillator circuit produces alternating current of frequency $f = \frac{1}{2\pi\sqrt{L_1 C}}$

* current is passed through the coil L1 and L2

* This current due to transformer ~~action~~ to the secondary circuit due to transformer action.

* This current is fed to the plates A and B.

* Due to inverse piezo electric effect. The crystal starts vibrating.

$$n = \frac{P}{2l}\sqrt{\frac{E}{\rho}}$$

n → frequency of quartz crystal

p → 1,2,3 for fundamental, First over tone and second overtone

E → youngs modulus of the crystal

ρ → Density of the crystal.

Advantage:

* More efficient than magnetostriction oscillator.
* can produce ultrasonic frequency of 500 MHz.
* It is not affected by temperature and humanity.

Disadvantage:

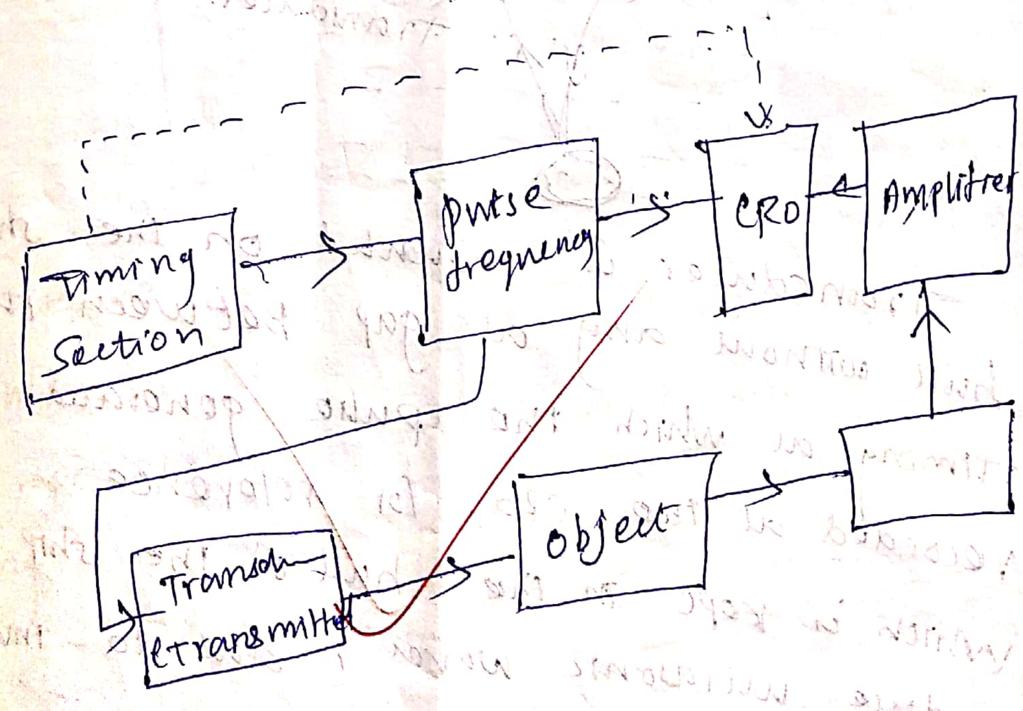
* cost is high
* cutting and shaping of piezo electric crystal is complex.

Sonar

It uses highly directional ultrasonic waves for locating objects and determination of their ~~the~~ distance in the sea.

principle:

When ultrasonic waves are transmitted through water, it is reflected by the objects in the water and will produce an echo signal, due to dopper effect help us to determine the velocity of the direction of the object.



Description:

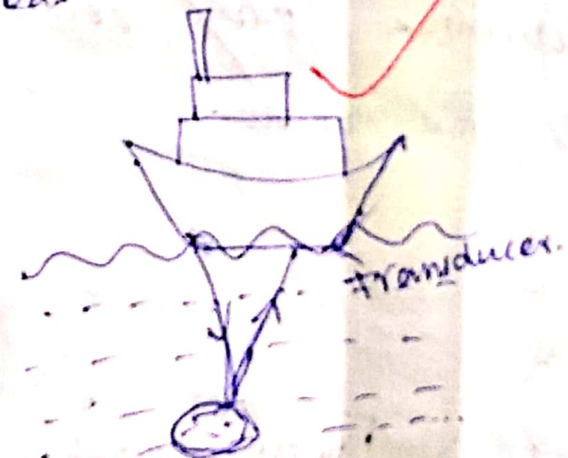
Timing section → triggers the elo pulse from the pulse generator

pulse Generator is connected to Transducer to produce ultrasonics

transducer is connected to CRO → display

Timing section is connected to CRO → reference of timing at which pulse is transmitted.

Working:



Transducer is mounted on the ships hull without any air gap between them

Timing at which the pulse generated is recorded at the CRO for reference

Which is kept in the hull of the ship to produce ultrasonic waves, due to inverse piezo electric effect.

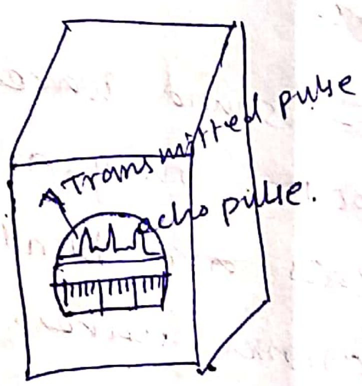
ultrasonic waves are transmitted thru the water in the sea.

On striking the object the ultrasonic waves are reflected in all direction.

These waves are picked by the receiver, os is again converted into electrical pulse due to piezo electric effect.

These pulse will be weak, and hence amplified and are recorded in CRO

Hence both transmitted pulse and the received echo pulse are recorded.



From the time interval and pulse height, b/w transmitted and received pulse, position, distance, and direction of moving obj can be calculated.

Section - B

ultrasonic:

1. ultrasonics is a branch of Physics which deals with the study of high frequency sound waves. sound is produced by vibrating bodies. Based on its frequency sound is classified into three categories. They are: Infrasonics, Audible waves and ultrasonic waves.

2. Infrasonics waves - sound waves with frequencies below 20 Hz. They are not audible to human ears.

3. Audible waves - sound waves with frequencies b/w 20,000 Hz. They are not audible to human. Bats are blind, but they can generate ultrasonics waves, which help to detect objects and obstacles by receiving the echo.

Properties:

* They are highly energetic because it is a high frequency wave.

* They can travel through a long distance without any loss in.

* Like ordinary sound waves, the ultrasonic waves are also reflected, refracted and transmitted

Working:

The ultrasonic waves are produced from the piezoelectric generator and is sent through the transducer. The waves (A) are recorded in (R) and is allowed to transmit through the specimen and are reflected back by the other end of the specimen. The depth of the defect in the specimen can be found out using the formula.

$$d = \frac{vt}{2}$$; where 'v' is the velocity of ultrasonics waves.

Uses:

* It is used for quality control
* It is used for inspection of materials.

ii.) Drawback of classical theory:

* It is microscopic theory
* classical Theory stats the all free electrons will absorb energy, but quatum theory stats that only few electrons will absorb energy.
* This theory cannot explain the compton, photo - electric effect, paramagnetism, ferroma-gnetism etc.

* The theoretical and experimental values of specific heat and electric specific heat is not matched.

* By classical theory $\frac{K}{\sigma T}$ = constant for all temperature but by Quantum theory $\frac{K}{\sigma T}$ ≠ constant for all temperature.

* The Lorentz number by classical theory does not have good with the experimental value and is rectified by Quantum theory.

PART-A

1.1. Magnetisation effect:

The term magnetisation is the process of converting a non magnetic material into a magnetic material. It measures the magnetisation of the magnetised specimen.

It is also defined as the magnetic moment per unit volume.

$$I = \frac{M}{V} = \frac{m \cdot l}{l \cdot a} = \frac{m}{a} = \text{weber}/m^2.$$

Photons:

photons, is derived from the word photon which is the smallest unit of light. according to Quantum theory, light consists of photons light source used in photonic include, LEDS, Diodes, and Laser.

Acousting

When ultrasonic waves passes through a liquid. stationary waves are produced due to alternate compression and Rarefaction.

Now liquid behave, as a diffraction grating called acoustic grating.

2

INTERNAL ASSESSMENT - 2

Waves and Optics – U18BSPH101

Date : 18.10.2019

Academic Year / Semester : 2019-2020/ODD   Duration : 1 hour 30 mins

Q.No	PART A (6 x 2 = 12) ANSWER ALL QUESTIONS	Weightage	CO	Bloom's Level
1	List out the conditions of total internal reflection?	2	CO3	R
2	State total internal reflection?	2	CO3	R
3	Recall the laws of refraction.	2	CO3	R
4	Illustrate the term wave front?	2	CO4	U
5	State the Huygens's principle	2	CO4	U
6	Summarize the principle of superposition of light waves.	2	CO4	U
	PART B (3 x 6 = 12) ANSWER ANY THREE QUESTIONS			
7(a)	Write a short note on mirage effect. (OR)	6	CO3	R
7(b)	Describe total internal reflection with a neat diagram.			
8(a)	$\mu = \tan i_p$ - Justify (OR)	6	CO6	A
8(b)	Express the principle for the formation of Newtons rings and relate with interference.			
9(a)	Describe briefly Young's double slit experiment?(OR)	6	CO4	U
9(b)	Draw a neat labelled diagram of Michelson's interferometer and explain briefly.			
	PART C (2 x 10 = 20) ANSWER ANY TWO QUESTIONS			
10(a)	Discuss briefly Fermat's principle. Show that the law of reflection and refraction at the plane surface.(OR)	10	CO3	R
10(b)	Describe with a neat sketch the essential parts of a compound microscope.			
11(a)	Using Young's double slit experiment, derive en expression for the bandwidth of monochromatic light.(OR)	10	CO4	U
11(b)	Discuss the Franhoffer diffraction of a light at a single slit.			

CO	Weightage
CO1	-
CO2	-
CO3	22
CO4	22
CO5	-
CO6	06
Total	50

Prepared by	Dr. C. Rathika Thaya Kumari	Signature
Verified by	Dr. R. Velavan HOD	Signature

Bharath Institute of Higher Education & Research

Department of Physics

Internal Assessment - 2

Waves and Optics - U18BSPH101

Answer Key

Part - A. (6 × 2 = 12)

1. Conditions for Total Internal Reflection: (2 Marks)

   Light rays move from more dense medium to less.
   Angle of incidence is greater than Critical angle.

2. Total Internal Reflection - (2 Marks)
3. Laws of Refraction - (2 Marks)
4. Wave front - (2 Marks)
5. Huygen's Principle - Statement (2 Marks).
6. Principle of Superposition of Waves - (2 Marks)

Part - B. (3 × 6 = 18)

7.(a) Mirage Effect - (6 Marks)
Explanation with diagram

7(b) Total Internal Reflection -
Condition - 2 Marks
Explanation - 4 Marks.

8(a) Brewster's law - 6 Marks.
Statement - 2 Marks
Explanation with Proof - 4 Marks.

8(b) Newtons Ring - 2 Marks.

Explanation - 4 Marks.

9(a) Youngs double Slit Experiment (6 Marks)

Explanation with diagram.

9(b) Michelson's Interferometer (6 Marks)

Construction - 2 Marks

Diagram - 2 Marks

Working - 2 Marks.

Part C (2 X 10 = 20)

10(a) Fermat's Principle

Laws of Reflection - 5 Marks.

Laws of Refraction - 5 Marks.

10(b) Compound Microscope - 10 Marks.

Diagram - 4 Marks

Explanation - 6 Marks.

11(a) Youngs double Slit Experiment - 10 Marks.

Explanation with diagram - 4 Marks

Expression - 6 Marks.

11(b) Fraunhoffer Diffraction

Explanation - 10 Marks.

U19CS035
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Part A

1. Light should travel from rarer medium to denser medium
The angle of incidence should be greater than the angle of critical angle.

3. The angle of incidence should be equal to the angle of refraction.

5. Each wavefront in a wavelet secondary should be equivalent to the corresponding wavefront to the wavelet.

6. Superposition of light waves, with the displacement of waves must be the sum of two or more individual waves.

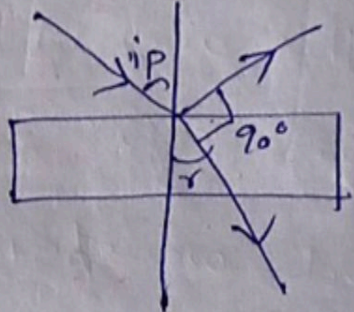
Part B

7(a) Mirage Effect:

The main Principle used in this is the total internal reflection. The image can be viewed from the reverse image. The ~~rao~~ incident light reflects on the image and the light gets reflected by total internal reflection and the inverted ~~image~~ reflected image can be viewed.

This can be seen in the sea water also near the sea shore we can see this mirage image.

8 a) Brewster's Law



The reflected and the refracted rays are at right angles to each other when the light is incident at polarizing angle.

$$i_p + 90 + r = 180$$

$$r = 180 - 90 - i_p$$

$$r = 90 - i_p.$$

$\therefore \dfrac{\sin i_p}{\sin r} = \mu$, the refractive index of glass.

$$\frac{\sin i_p}{\sin (90 - i_p)} = \mu.$$

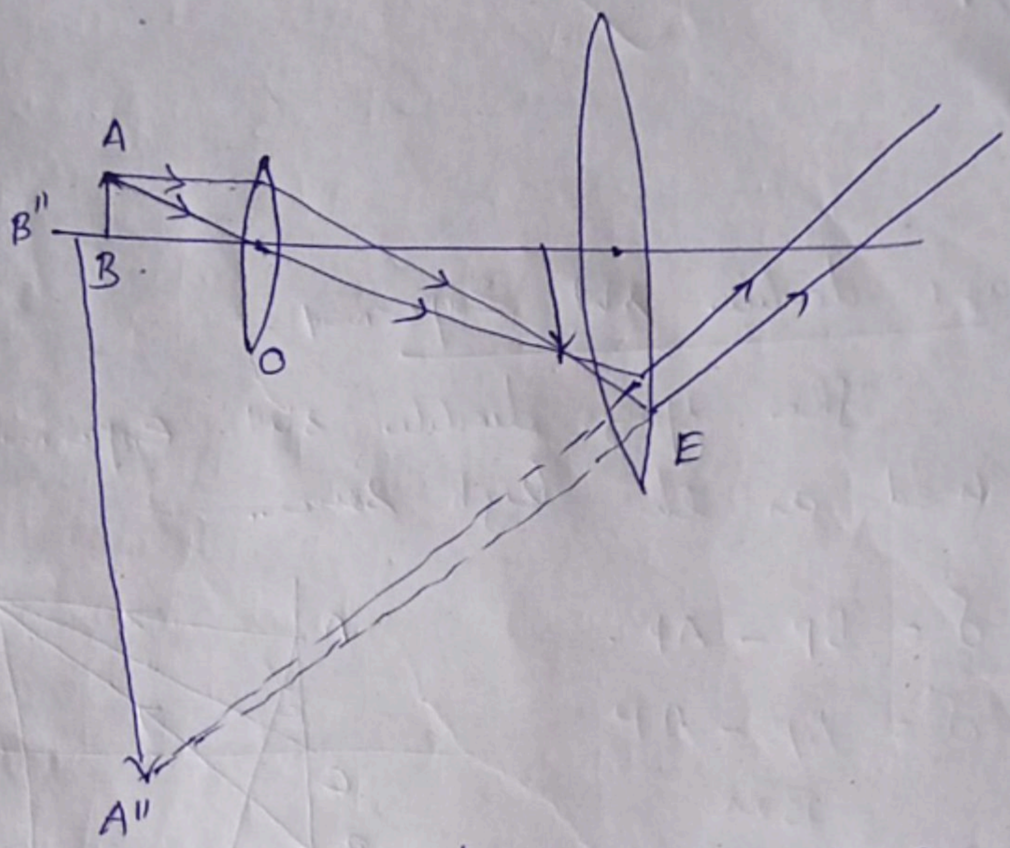
$$\frac{\sin i_p}{\cos i_p} = \mu$$

$$\boxed{\tan i_p = \mu}$$

The tangent of angle of polarization is equal to the refractive index of the medium.

Part c

b)



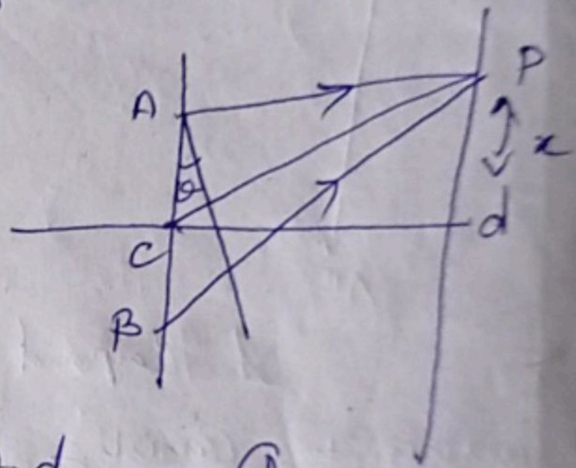
A Compound microscope is an optical instrument Consisting of two Convex lenses of short focal length which is used for observing the highly magnified images of tiny objects.

It has two Convex lenses. The lenses are placed towards the object Called objective lens. while the lens towards our eye is Called eye piece. The focal length of two lenses are short the Objective lens of focal length is little shorter than the focal length of eyepiece. This is because it receives more light rays from the object and forms a bright image.

8

11. a) Young's double slit Experiment

The Youngs double slit experiment is used as the light source.



$\delta = BP - AP$.

$\delta = BP - AP$

$= BM$

$BM = d \sin\theta$.

Path difference $\delta = \theta d$ — ①.

$\frac{xd}{D} = n\lambda$

$x = \frac{n\lambda D}{d}$ — ②.

$x = (2n-1)\frac{\lambda}{2} \cdot \frac{D}{d}$ — ③.

2½

$\therefore \boxed{\beta = \frac{\lambda D}{d}}$

IA - 2

Waves and Optics

44/50

Name : A. Abinaya

Reg No: U19CS007

Part - A

1. Light should travel from denser medium to rarer medium. The angle of incidence should be greater than critical angle.

2. The angle of incidence inside the denser medium in the core should be greater than the critical angle ϕ_c, then the light undergoes total internal reflection.

3. The angle of incident ray should be equal to the angle of refracted ray. The incident ray, refracted ray and the plane should lie on the same point.

5. All wave points of a wavefront of light in a vaccum may considered as a new sources of wavelets that expand in every direction.

6. When two or more waves crosses at a point, the displacement at the point is equal to the sum of the displacements of individual waves.

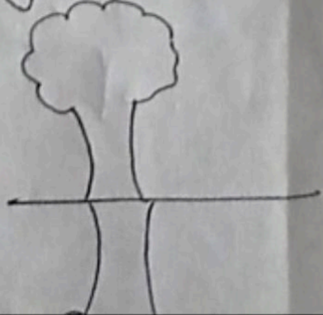
Part - B

7. a) Mirage Effect

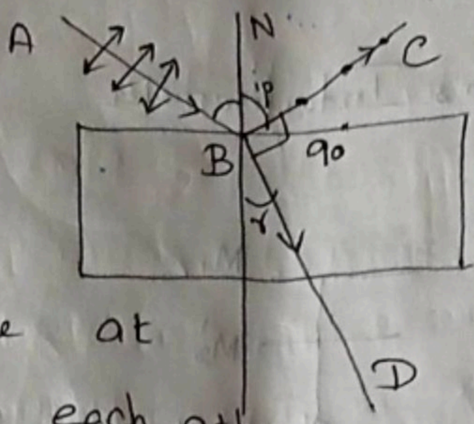
It is an optical illusion caused due to total internal reflection of light in sandy deserts or in some extended surfaces like black tarred road in very hot weather.

In hot summer days, sandy land become hot during day time. The air in contact becomes hot. So refractive index less and density is reduced, where the density of air at higher level remains unaffected. Thus the layers of air near ground are warm than the air at upper level.

Thus, when the ray of light from the top of tree travels from denser to rarer medium it bends away from a normal, & hen total internal reflection occurs. Hence the tree inverted image can be seen by the observer. This gives an optical illusion.



8 a)



The reflected ray and the refracted rays are at right angles to each other, when the light is incident at a Polarising angle ip.

$$i_p + 90^\circ + r = 180^\circ$$

$$r = 180^\circ - 90^\circ - i_p$$

$$r = 90^\circ - i_p$$

From Snell's law,

$$\frac{\sin i_p}{\sin r} = \mu$$

$$\frac{\sin i_p}{\sin(90 - i_p)} = \mu$$

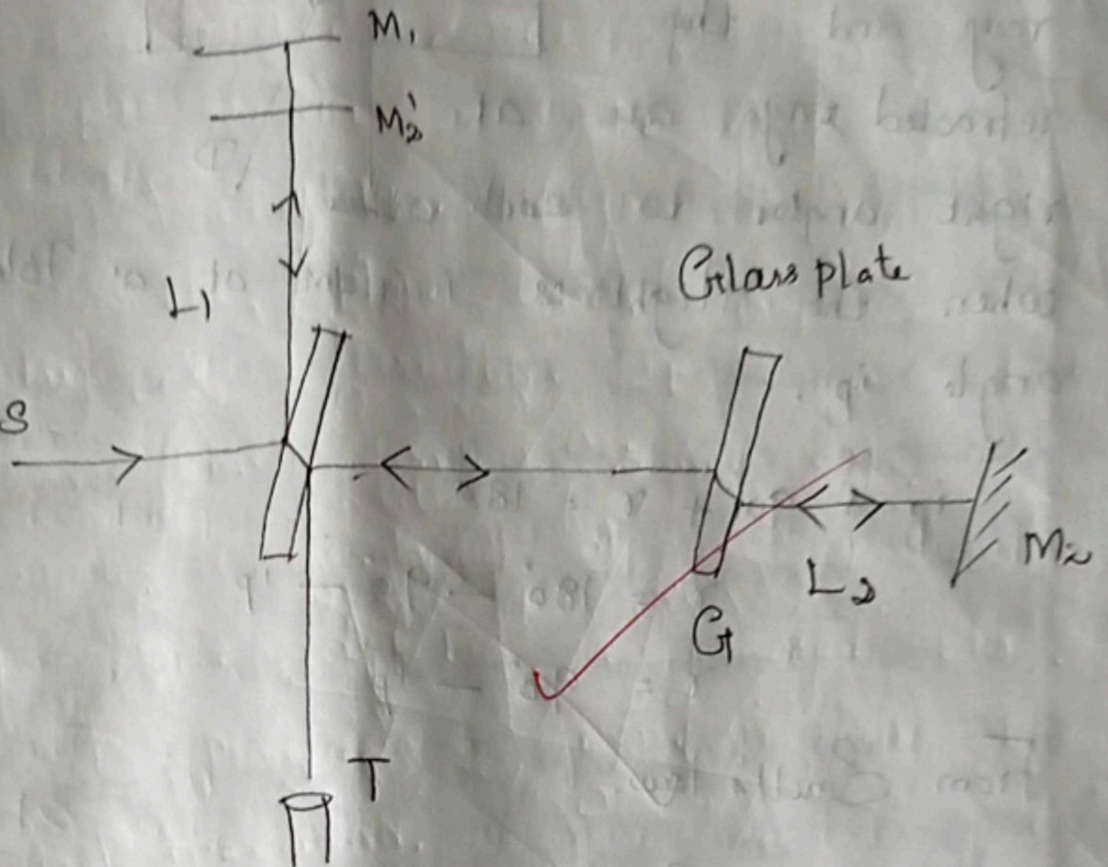
$$\frac{\sin i_p}{\cos i_p} = \mu$$

$$\Rightarrow \tan i_p = \mu$$

Hence Proved.

9(b) Michealson's Interferometer

7.



The ray of light from a source is made to fall on the mirror M. which falls on the beam splitter. This will split into the two rays, one half is transmitted and other is reflected. The reflected ray from M, reflect vertically upward towards the M₁. and transmits horizontally towards M₂.

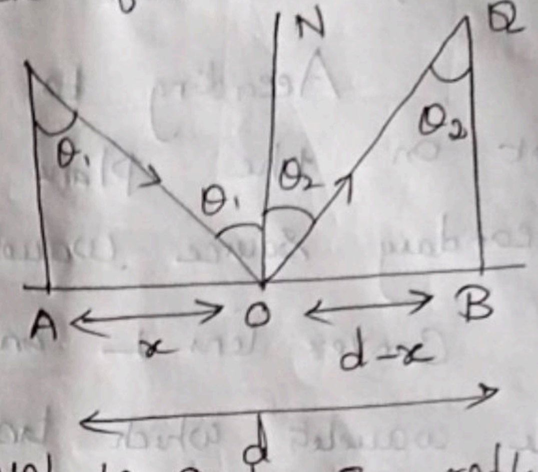
5

Hence, Magnification, $m = \frac{D}{f_o} \times \frac{L}{F_e}$.

Part - c

10. a) Fermat's Principle:

Light has taken a path, which takes least time to reach from one point to another.



Let N be the normal ray to the incident and reflected ray. The angle of incidence is equal to angle of reflection. $\theta_1 = \theta_2$. This can be proved by Fermat's Principle.

Let $OA = x$. $AB = d$. $OB = d - x$.

$$t = \frac{PO}{V} + \frac{OQ}{V}$$

$$= \frac{\sqrt{h_1^2 + x^2}}{V} + \frac{\sqrt{h_2^2 + (d-x)^2}}{V}$$

$$\therefore \frac{dt}{dx} = \frac{1}{V}\left[\frac{x}{\sqrt{h_1^2 + x^2}} - \frac{d-x}{\sqrt{h_2^2 + (d-x)^2}}\right]$$

Let $\frac{dt}{dx} = 0$;

$$\frac{1}{V}\left[\sin\theta_1 - \sin\theta_2\right] = 0.$$

$$\sin\theta_1 = \sin\theta_2$$

$$\theta_1 = \theta_2$$

Thus Proved by Fermat's Principle.

11. b) Fraunhoffer Diffraction.

Consider a plane wave front from a monochromatic source of light with wavelength incident on slit AB.

According to Huygen's Principle, every point on the plane wavefront act as a secondary source wavelets. It is focussed by a convex lens L on a screen XY.

The wavelets which travel along equal distance in the same direction is focussed at O. Thus it produces maximum intensity known as Central maximum.

$\therefore$ Path diff. = $BP_1 - AP_1$

$= BP_1 - GP_1 = BG$.

$\therefore BG = a \sin\theta$.

$\therefore$ Whole slit AB is divided into two halves as $AC = BC = a/2$.

$\therefore$ Path difference will be zero.

For first minimum, $\theta = \lambda/a$.

$\therefore$ [

The condition for n^{th} minimum is

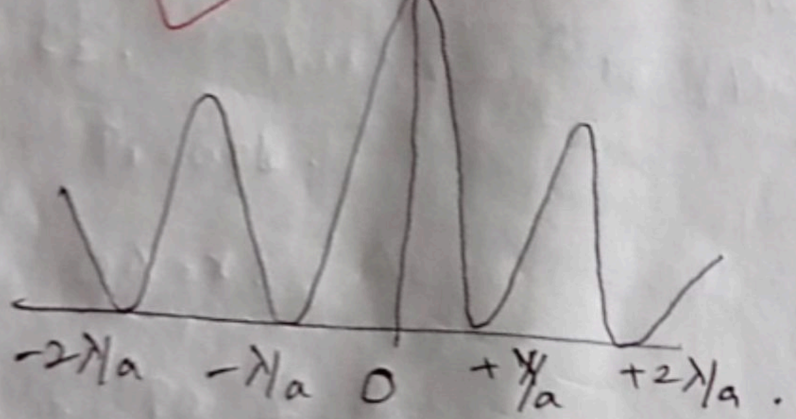
$$a \sin\theta = n\lambda, \quad n = 1, 2, 3 \ldots$$

$$\theta = n\lambda / a.$$

The condition for secondary maxima is

$$\theta \sin\theta = (2n+1)\lambda/2.$$

$$\theta = \frac{(2n+1)\lambda}{2a}.$$



DEPARTMENT OF PHYSICS

ASSIGNMENT QUESTIONS

Assignment – 1

1. Explain different modes of vibration in Carbondioxide Laser?
2. Examine the atoms position in the emission of Laser light and represent it with the help of transition diagram.
3. Find the ratio of population of the two energy states of active medium producing laser transition between which has the wavelength 6328 Å. Assume temperature = 300 K. Hint: $N = N0e^{-E/KT}$, $E = hc/\lambda$.

Assignment – 2

1. Sketch the lens position to show the image for the following conditions:
   a) Image formed by a converging lens when the object distance is greater than 2f.
   b) Real and enlarged image formed by a converging lens when the object distance is greater than f and less than 2f.
   c) Virtual, enlarged image formed by a converging lens when the object distance is less than f.

R. Velavan

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PHYSICS

ASSIGNMENT – 1

10/10

NAME: ALAMURU LIKITHA

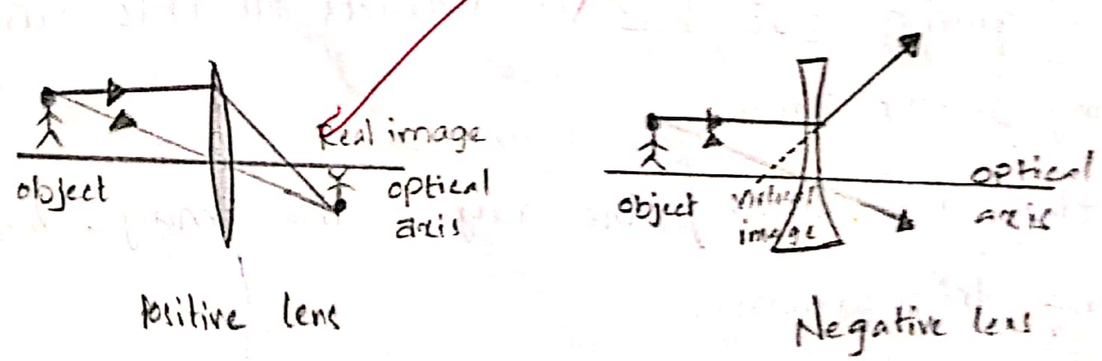
REG NO: U19CS037

DEPT: CSE

* Lenses, Mirrors & Optical instruments *

Lenses & Mirrors:- A lens is a transparent device with two Curved Surfaces, usually made of glass or plastic, that uses refraction to form an image of an Object.

A lens is a transparent device with two Curved Surfaces. Mirrors, which have Curved Surfaces designed to reflect rays, also forms images. A system of lenses and/or mirrors forms an image by gathering rays from an object and then Causes them to Converge or diverge. The position to which the rays Converge or diverge form is the image. A real image is formed when the Optical System Causes the rays to converges to a point, a virtual image is formed at the location from which they Seem to Originate.



Depiction of lenses forming real and Virtual images. Positive and negative lenses can both form real and virtual images.

The effect of lenses and mirrors on a ray can be determined using fermat's principle, through trignometry and the application of Snell's law, to the trace of a path of a light ray from a point on the source to the image point. This is done by

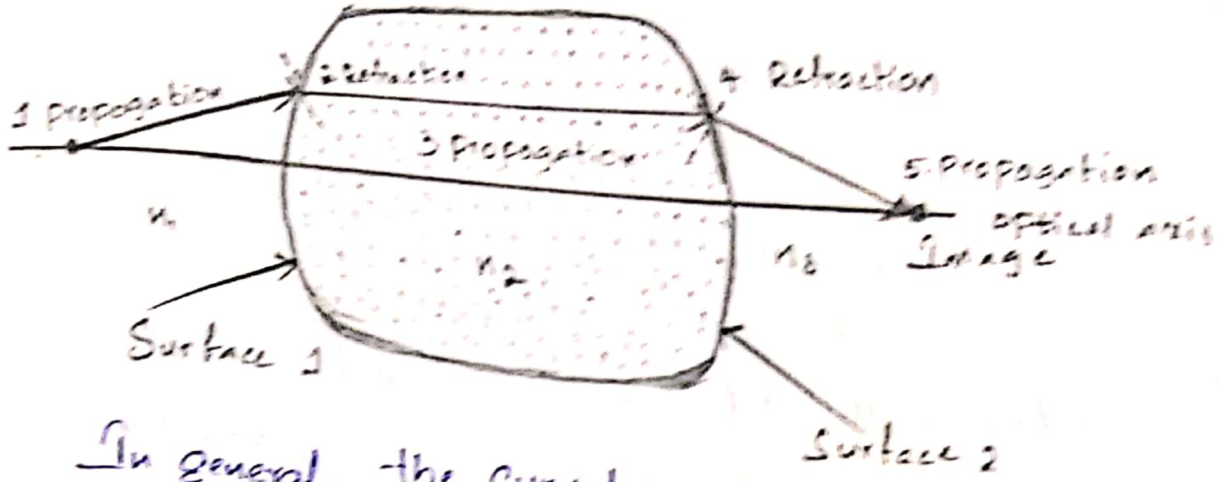
1) Tracing a ray from the Object to the first Surface of the lens using Trignometry.

2) Determining how the ray refracts at the first interference using Snell's law.

3) Tracing the ray to the Second interface using the trignometry.

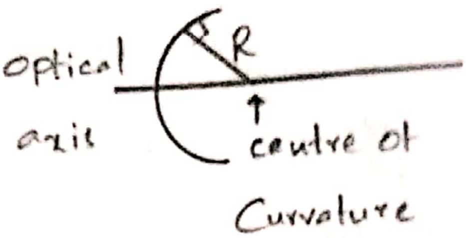
4) Figuring Out how it refracts at this Surface Using snell's Law.

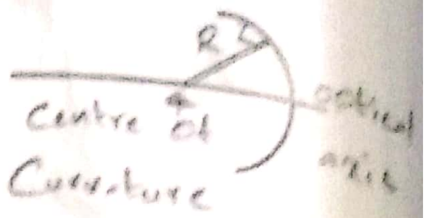
5) And then tracing the ray to the image location Using trignometry.



In general, the curvature of one side of the lens is different than that of the other side of the lens. The curvature of a lens surface is the inverse of radius of curvature of the surface $C = 1/R$. The curvature is positive when the centre of curvature is to the right of surface and negative when the centre of curvature to the left of the surface.

Lens or mirrors with flat surfaces are said to have an infinite radius of curvature





Surface with (+) of the Curvature

Surface with (-) of the Curvature

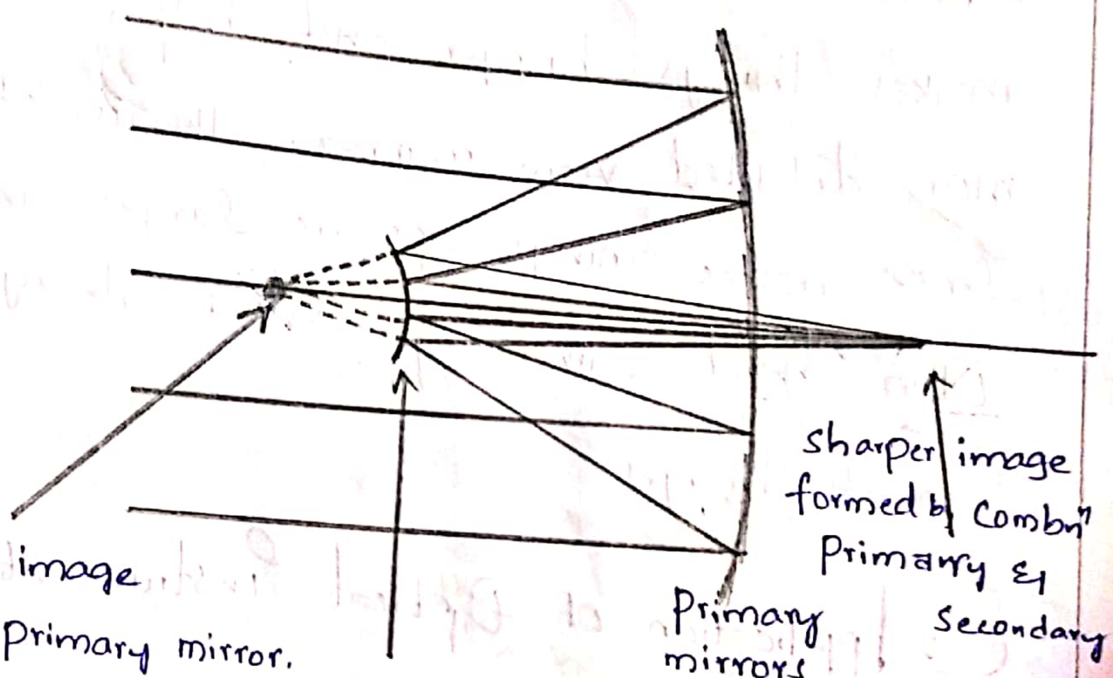
A simple expression that describes how a thin lens image an Object is called "Thin lens eqn". It is a good way to figure Out the location of an image, if the distance b/w the Object and lens and the focal length of the lens are known. This eqn assumes that air surround the Object, image and lens.

$$\frac{1}{d} + \frac{1}{d'} = \frac{1}{f}$$

Magnification (m) $= -\frac{d'}{d}$

$h_{image} = m\, h_{object}$

The hubble space telescope has the form of a Ritchey - chretian Telescope. This telescope increases it's field of view by using a hyperboloids as both primary and second mirrors.



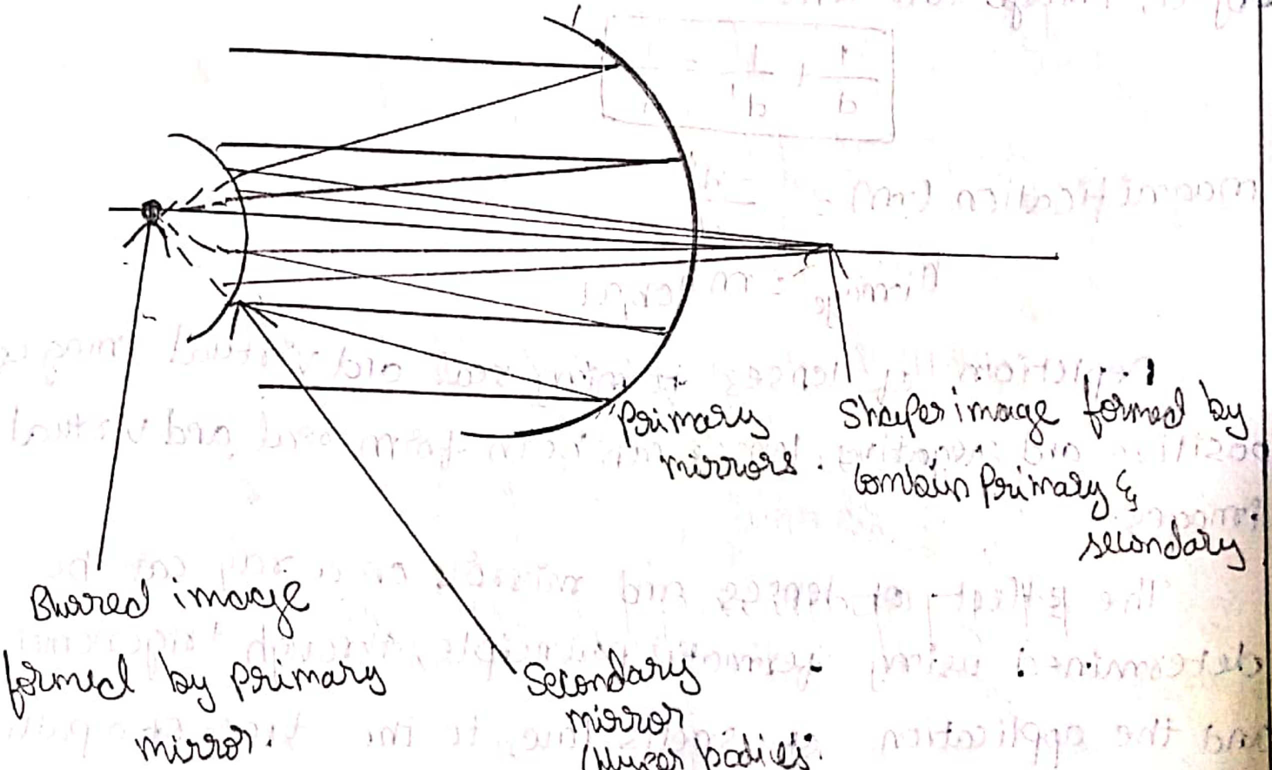
Ritchey - chretein - Telescope.

* *

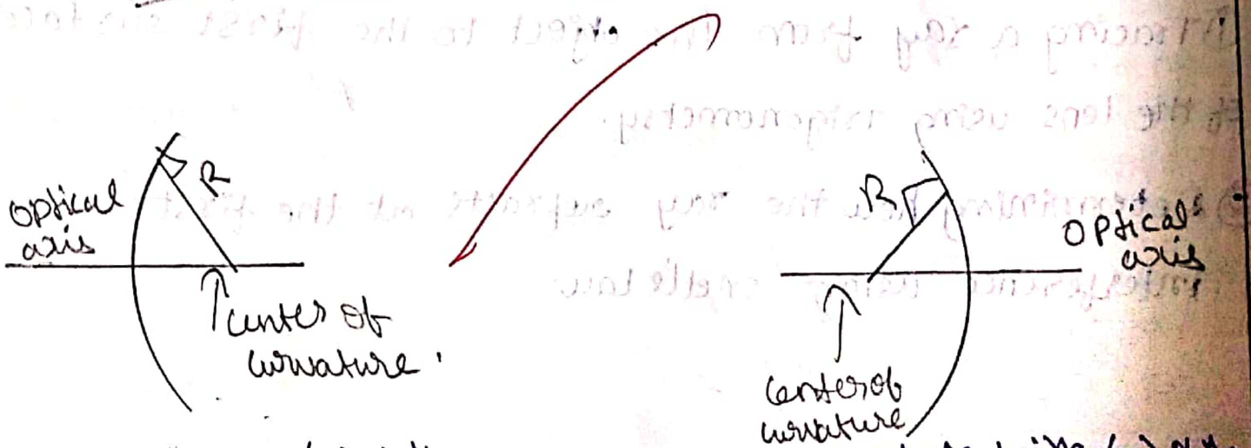
LENSES, MIRRORS & OPTICAL INSTRUMENTS

7/10

The hubble Space telescope has the form of a Ritchey - chretian telescope. This telescope increases it's field of view by using a hyperbolaids as both primary and second mirrors.



Ritchey - Chretein - Telescope



Surface with (+) of the curvature

Surface with (-) of the curvature.

3) Tracing the ray to the second interface using trigonometry.

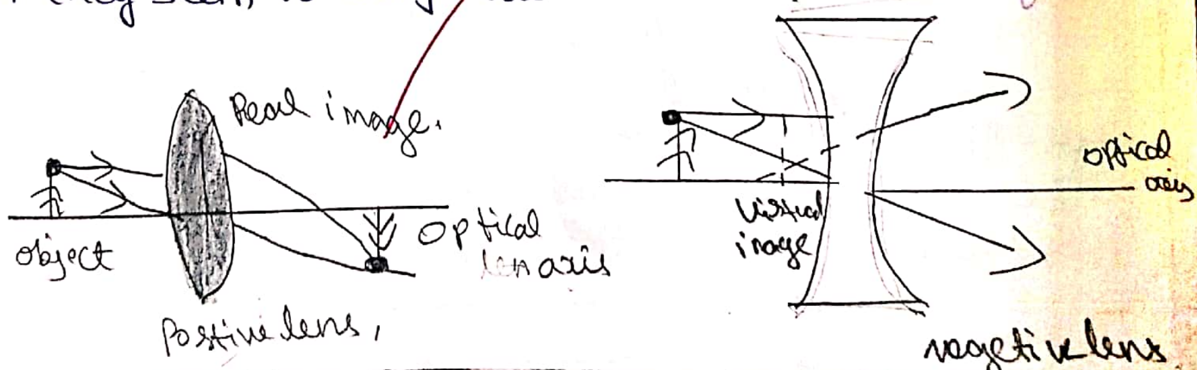
4) Figuring out how it refracts at this surface using snell's law.

5.) And the tracing the ray to the image location using trigonometry.

lenses & mirrors :-

A lens is a transparent device with two curved surface. Usually made of glass (or) plastic that uses refraction to form an image of an object.

A lens is a transparent device with two curved surfaces mirrors which have curved surfaces designed to reflect rays also forms images. A system of lenses and mirrors form an image by gathering rays from an object and then causes them to converge (or) diverge. The position to which the rays converge (or) diverge form is the image. A real image is formed when the optical system causes the rays to converges to a point. a virtual image is formed ~~at~~ at the location form which they seem to originate.



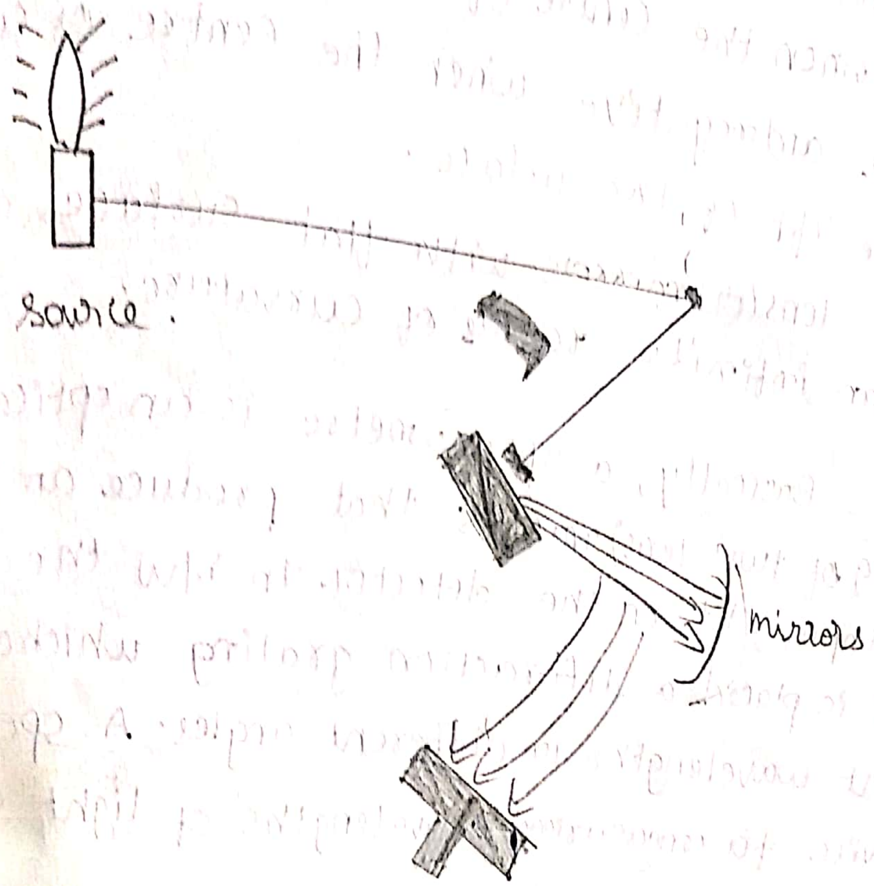
Optical instruments :- These are the devices which process light way to enhance an image for more clear view. Use of an instrument of the optical such as a magnifying lens (or) any complicated devices like microscope (or) telescope. Usually makes things bigger and helps us to see in a more detailed view manner. The use of converging lenses always gets you smaller images.

Application of optical instruments

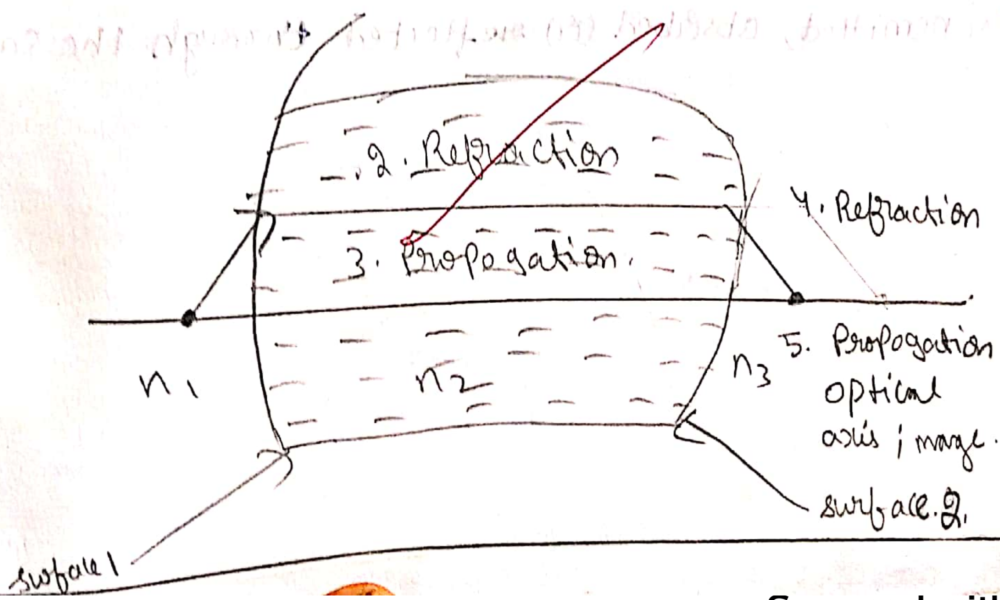
Microscope :- A microscope has two converging lens.. This because it is easier to get higher magnification with two lenses rather then just one. Use of one lens can magnify 1-times more and using a second will magnify 7-times you will get all magnification of 35 which is not possible in one lens. It's an easy procedure that to get magnification by a factor of 35 with a single lens. A ray diagram of microscope arrangement is given below. Here you can see the image is.

U19CS045

Spectrometers: An optical spectrometre is an instrument used to measure properties of light over a specific portion of the electromagnetic spectrum.



A spectrometer is used in spectroscopy for producing spectral lines.



In general, the curvature of one side of the lens is different than that of the other side of the lens. The curvature of a lens surface is the inverse of radius of curvature of the surface $C = 1/R$. The curvature is positive when the centre of curvature is to the right of surface and negative when the centre of curvature is to the left of the surface.

lens (or) mirrors with flat surfaces are said to have an infinite radius of curvature.

Basically, a spectrometre is an optical system consisting of two lens/mirrors that produce an image of the input slit on the detector. In b/w the lenses/mirrors is placed a diffraction grating which disperses different wavelengths in different angles. A spectrometer is a device for measuring wavelengths of light over a wide range of the electromagnetic spectrum. It is widely used for spectro-scopic analysis of sample materials. The incident light from the light source can be transmitted, absorbed (or) reflected through the sample.

Assignment - 2

Carbon di oxide Laser

7/10

Ru

Submitted by

Name : Ala Nikhil Kumar Reddy

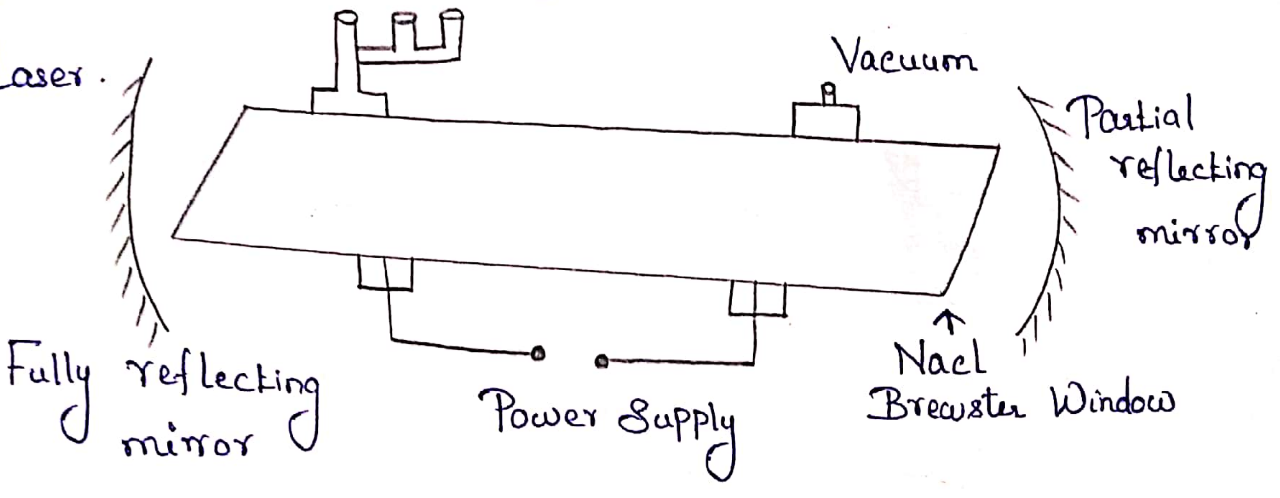
Reg No : U19CS036

Dept : CSE

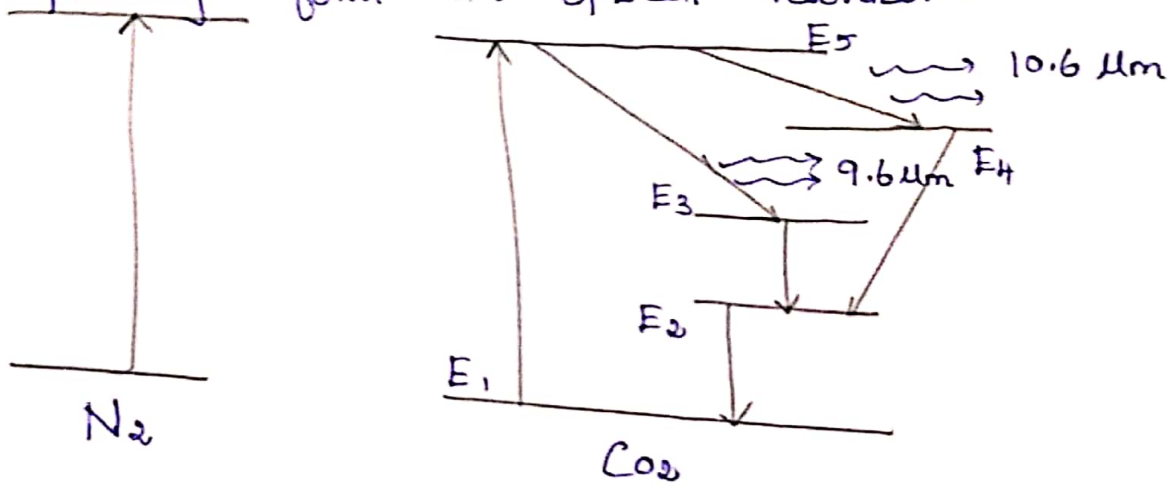
Carbon di oxide Laser: -

In a molecular gas laser, laser action is achieved by transitions between Vibrational. and rotational levels of molecules. Its Construction is Simple and the output is Continuous. The transition takes Place between the Vibrational states of Carbondioxide molecules.

CO_2 Laser was the first molecular gas laser developed by Prof C.K.N. Pillai. It is a four level laser and it operates at 10.6 Um in the far IR region. It is a Very efficient Laser.



It Consists of a quartz tube 5m long and 2.5 cm in the diameter. This discharge tube is filled with gaseous mixture of CO_2, helium and nitrogen with suitable Partial Pressures. The terminals of the discharge tubes are Connected to a D.C Power supply. The ends of the discharge tube are fitted with Nacl Brewster windows so that the laser light generated will be Polarized. Two Concave mirrors one fully reflecting and the other Partially form an optical resonator.



When an electric discharge occurs in the gas, the electrons Collide with nitrogen molecules and they are raised to excited states.

$$N_2 + e^* \rightarrow N_2^* + e^-$$

Now Nitrogen molecules collide with CO_2 atoms in the ground state and excited to higher levels.

$$N^* + CO_2 \rightarrow CO_2^* + N_2$$

The Population in E5 increases. As soon as, reached Laser lights are emitted with a wavelength of 10.6 & 9.6 μm.

PHYSICS
ASSIGNMENT-2

10/10

Ru

Name : Anagani Harsha Vardhan
Reg No : U19CS053
Dept : CSE
Topic : Carbon di oxide

CO_2 Laser :

CO_2 is The first Molecular Laser which was developed by Prof. C.K.N. Patel. In This Laser, the Laser Oscillations are achieved by the transistions b/w vibrational and rotational Levels of the Molecules.

vibrational modes of CO_2

There are Three modes of vibration they are.

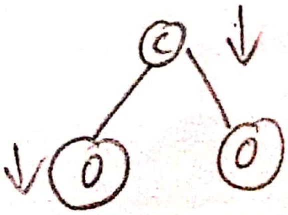
1. Symmetric stretching mode
2. Bending mode
3. Assymmetric Stretching mode

symmetric stretching mode :

The carbon atom is fixed at the centre, and the oxygen atoms vibrate simultaneously in opposite direction along the axis.

Bending mode of vibration :

All the atoms vibrate perpendicular to the axis



Assymmetric stretching mode:

All the three atoms oscillate. The oxygen atoms move in one direction while the carbon atom moves in opposite direction.

Principle:

1. Active medium is a mixture of CO_2, N_2 and He gases.

2. By electrical discharge method, nitrogen molecules are raised to excited state.

3. Laser transistion takes place.

Construction:

* It consists of a quartz discharge tube of length 5 m and diameter 2.5 cm

* The discharge tube is filled with the mixture of CO_2, N_2 and He gases.

* The optical resonator is formed with two concave mirrors, one fully reflecting mirror and other partially reflecting mirror

Working :

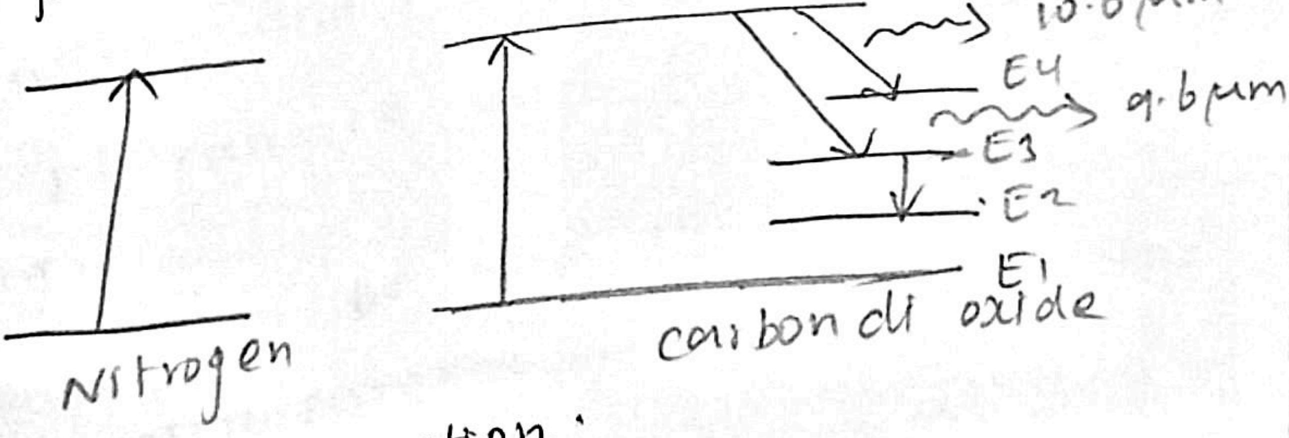
When the power supply is switched on the excited electrons collide with the nitrogen molecules and raised to the excited state.

$$N_2 + e \longrightarrow N_2^* + e$$

$$N_2^* + CO_2 \longrightarrow CO_2^* + N_2$$

Since the excited level of Nitrogen is very close to the energy state E5, the population inversion is achived in the Energy state E5

Finally, two laser transistions may takes place.



(i) E5 - E4 Transistion :

This transistion may produces a Laser beam of wavelength 10.6 μm.

(ii) E5 - E3 Transistion :

This transistion may produce a Laser beam of wavelength 9.6 μm.

Advantage:

* The design is simple and efficiency is high

* It can produce high output power.

Disadvantages:

* This Laser light may cause eye damage.

* output power depends on operating temp.

Applications:

1. It can be used in welding, drilling, cutting and soldering

2. It can be used in Laser remote sensing.

3. It can be used in the treatment Lungs, micro surgery, bloodless operations. etc.

QP CODE: U18BSPH101

Reg. No.									

BHARATH INSTITUTE OF HIGHER EDUCATTION AND RESEARCH
(Declared as deemed to be University under section 3 of UGC act 1956)
173, Agaram Main Road, Selaiyur, Chennai – 600 073, Tamil Nadu

SEMESTER EXAMINATIONS – NOV/DEC 2019
B.Tech – Waves and Optics – U18BSPH101

Time: 3 Hours **Max Marks: 100**

PART – A (10 X 2 = 20 MARKS)
ANSWER ALL QUESTIONS

		BT	CO	Marks
1.	Define Wavelength and Amplitude of the wave.	R	CO1	2
2.	What is meant by group velocity?	R	CO1	2
3.	What is called NDT?	U	CO2	2
4.	The interval between the transmitted & received ultrasonic signal is 8 sec. Determine the depth of the sea. [Given Velocity of sound is 1570 m/s].	U	CO2	2
5.	Mention the conditions for total internal reflection.	R	CO3	2
6.	State Fermat's principle.	R	CO3	2
7.	Define interference of light.	U	CO4	2
8.	In Fraunhoffer diffraction from a single slit, what is the condition for path difference in order to make constructive interference?	U	CO4	2
9.	What is population inversion?	U	CO5	2
10.	What are the components of laser?	U	CO5	2

PART – B (5 X 6 = 30 MARKS)
Answer either (a) or (b) from each question

		BT	CO	Marks
11a.	What are standing waves? Derive an expression for it.	R	CO1	6
11b.	Give a brief account on harmonics.			
12a.	Describe the detection of ultrasonics.	U	CO2	6
12b.	Explain sonogram with a neat diagram.			
13a.	Derive the laws of reflection based on the Fermat's principle.	R	CO3	6
13b.	State and prove Brewster's law.			
14a.	State and explain Huygens Principle of secondary waves.	U	CO4	6
14b.	Explain the formation of Newton's rings using amplitude splitting.			
15a.	Explain Absorption, Stimulated emission and Spontaneous emission of light.	U	CO5	6

15b. Write short notes on medical applications of laser.

	PART – C (5 X 10 = 50 MARKS) ANSWER ANY FIVE QUESTIONS	BT	CO	Marks
16.	Explain superposition of waves.	R	CO1	10
17.	Explain the construction and working of Magnetostriction oscillator with a neat diagram.	U	CO2	10
18.	Explain Compound microscope with neat diagram.	R	CO3	10
19.	Explain Fraunhoffer diffraction from a single slit with diagram.	U	CO4	10
20.	Explain the construction and working of He-Ne LASER.	U	CO5	10
21.	Derive Einstein's coefficient using Einstein's theory of matter - radiation interaction.	A	CO6	10
22.	What are longitudinal waves? Derive longitudinal wave Equation.	A	CO6	10

R. S. Lavan

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Selaiyur, Chennai-600 073, INDIA

Bharath Institute of Higher Education & Research
End Semester Examination - 2019-20

Waves & Optics - **Answer Key** Max. Marks - 100

U18BSPH101 **Part-A** (10 x 2 = 20)

1. Wavelength - 1 Mark
   Distance between the two successive crests
   Amplitude - 1 Mark
   Maximum displacement
2. Group Velocity - 2 Marks
3. NDT - 2 Marks
   Non destructive Testing to detect the defects.
4. $V = 2d/t$ - 2 Marks.
5. Light travel from denser to rarer medium
   Angle of incidence should be greater than ϕ_c.
6. Fermat's Principle - 2 Marks
   based on light reflection.
7. Interference of light Waves - 2 Marks.
8. $2d \sin\theta = n\lambda$ - 2 Marks
9. Number of atoms should be more in excited state than ground state. - 2 Marks.
10. High Intensity, Directionality, Monochromaticity, Coherence - 2 Marks

Part-B (5×6 = 30)

11.a) Standing Waves – 2 Marks
Expression – 4 Marks.

b) Harmonics – 6 Marks.
Fundamental freq, first overtone freq, Sec. over freq.

12.a) Detection – 6 Marks.
Kundt's tube Method, Sensitive flame Method, Thermal Method, Piezo elec. detector.

b) Sonogram – 6 Marks.
Block diagram – 2 Marks.
Explanation – 4 Marks.

13.a) Laws of Reflection on Fermat's Principle – 6 Marks.

b) Brewster's Law – 6 Marks
Statement – 2 Marks.
$\tan i_p = \mu$ – 4 Marks.

14.b) Newton's Ring:
Explanation with diagram – 6 Marks.

a) Huygen's Principle – 6 Marks.

15.a) Absorption – 2 Marks
Spon. Emission – 2 Marks
Stim. Emission – 2 Marks.

b) Medical Applications of Laser:
Any 6 – 6 Marks.

Part-C (5×10 = 50)

16. Superposition of Waves: (10 Marks)
    Explanation with diagram

17. Magnetostriction Oscillator:
    Principle – 2 Marks
    Circuit – 3 Marks
    Explanation – 4 Marks
    Resonance Condn – 1 Mark.

18. Compound Microscope
    Diagram – 2 Marks
    Explanation – 8 Marks.

19. Fraunhoffer Diffraction.
    – 10 Marks.

20. He - Ne Laser: Construction – 2 Marks
    Diagram – 3 Marks.
    Working – 5 Marks.

21. Einstein Coefficient:
    Derivation – 10 Marks.

22. Longitudinal Waves – 2 Marks
    Derivation – 8 Marks.

DEPARTMENT OF PHYSICS

TEXT BOOKS & REFERENCES

COURSE NAME: WAVES & OPTICS

COURSE CODE: U18BSPH101

LIST OF TEXT BOOKS

R1. M.N. Avadhanulu and P.G. Kshirsagar, "A Textbook of Engineering Physics" S.Chand Publishers, 2016 (for Units 1,3,4& 5)

R2. G.Senthil Kumar, "Engineering Physics", VRB publishers, Chennai, 2015 (for Unit 2)

LIST OF REFERENCE BOOKS

R3. BrijLal and Subramanian, "Waves and Oscillation", VikasPublishsing House, 2011

R4. R.Murugesan,"Optics and Spectroscopy", S.Chand Publishers, 2015

R5. BrijLal and Subramanian,"Optics", S.Chand Publishers 2006

R6. Ian G. Main, "Vibration and waves in physics", Cambridge University Press, 1978

R7. H.J. Pain, "The physics of vibrations and waves", 6th edition, Wiley 2006

R8. AjoyGhatak, "Optics", Tata McGraw-Hill publishing company, New Delhi, 2009

R9. O. Svelto, "Principles of Lasers", Springer, 2010

R10. Online reference – Waves & Oscillations by Prof. M. S. Santhanam, IISER Pune.

Web link: https://onlinecourses.nptel.ac.in/noc19_ph18

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(Declared as Deemed - to - be - University under section 3 of UGC Act 1956)

DEPARTMENT OF PHYSICS

Subject Title: **WAVES & OPTICS** Subject Code: **U18BSPH101**

QUESTION BANK 2019-2020 (ODD SEMESTER)

Unit I - NON DISPERSIVE TRANSVERSE AND LONGITUDINAL WAVES IN ONE DIMENSION

Part A (2 Marks)

1. How sound waves are produced?
2. How sound waves are classified?
3. What are longitudinal and transverse waves?
4. Define Wavelength and Amplitude.
5. Define Group velocity.
6. Define nodes and antinodes.
7. State the principle of superposition of sound waves.
8. Define beat frequency.
9. What are the conditions necessary for interference?
10. What is dispersion of wave?

Part B (6 Marks)

1. Discuss briefly the wave parameters.
2. What are the characteristics of waves?
3. What are the properties of stationary waves?
4. Give brief explanation about the harmonics.
5. Explain the phenomenon of interference of light.
6. Write short note on beats and its uses?

Part C (10 Marks)

1. Derive the wave equation of a longitudinal wave.
2. Derive the wave equation of a transverse wave.
3. Discuss the behavior of a wave at different boundaries.
4. Explain in detail about superposition of waves.
5. What are stationary waves? How are they produced?

Unit II - ULTRASONIC WAVES

Part A (2 Marks)

1. Define ultrasonic waves.
2. State the properties of ultrasonic waves.
3. What is piezoelectric effect?
4. What is magnetostriction effect?
5. What is inverse piezoelectric effect?
6. What is NDT? Give two examples.
7. How the natural frequency of a crystal is calculated?
8. Calculate the natural frequency of iron rod of 0.03 m length. The density of iron is 7.23×10^3 kg/m^3 and Young modulus is 11.6×10^{10} N/m^2
9. What are the methods used to detect ultrasonic waves?
10. What is SONOGRAM?
11. What is an acoustic grating?
12. What are the types of ultrasonic imaging system?

Part B (6 Marks)

1. Mention the merits and demerits of piezoelectric oscillator.
2. Discuss the different methods used for ultrasonic wave detection.
3. Describe the medical applications of ultrasonic waves.

4. Explain sonogram with a neat diagram.
5. Discuss the different modes of displaying the results of ultrasonic imaging system.
6. Describe the industrial applications of ultrasonic waves.

Part C (10 Marks)

1. Explain the phenomenon of magnetostriction. How high frequency sound waves are produced using magnetostriction oscillator?
2. What is piezoelectric effect? Explain how ultrasonic waves are produced by piezoelectric transducer.
3. Explain how the velocity of ultrasonic wave is determined using acoustic grating.
4. What is NDT? Describe the ultrasonic non-destructive method used for flow detections.
5. Explain the industrial and medical applications of ultrasonics.

Unit III - THE PROPAGATION OF LIGHT AND GEOMETRIC OPTICS

Part A (2 Marks)

1. Define Brewster's law.
2. What are the conditions of total internal reflection?
3. What is meant by total internal reflection?
4. State the laws of refraction.
5. State Fermat's principle.
6. What are electromagnetic waves?
7. Define reflectance and transmittance.
8. What is mirage effect?
9. What is a magnifying power of a microscope?
10. What are the components of spectrometer?

Part B (6 Marks)

1. Prove that $\mu = \tan i_p$
2. Discuss in detail about the law of reflection of light.
3. Discuss about the law of refraction.
4. Write a short note on mirage effect.
5. Describe total internal reflection with a neat diagram.

Part C (10 Marks)

1. Discuss briefly Fermat's principle. Show that the law of reflection and refraction at the plane surface
2. Describe with a neat sketch the essential parts of a compound microscope
3. Describe a prism spectrometer. How will you find the refractive index of the material of a prism?
4. What are electromagnetic waves? Discuss light as an electromagnetic wave.
5. (i) Write a short note on Total Internal Reflection
   (ii) Prove that $\mu = \tan i_p$

Unit IV - WAVE OPTICS

Part A (2 Marks)

1. What is wave front?
2. State the Huygens's principle
3. State the principle of superposition of light waves.
4. What is interference of light?
5. Write the two class in to which the phenomenon of interference is divided
6. State the condition for the formation of bright and dark fringes.
7. What is diffraction of light?
8. What is diffraction grating?
9. Why compensating glass plate is introduced in Michelson's interferometer?
10. What are the types of wave front?

Part B (6 Marks)

1. Draw a neat labeled diagram of Michelson's interferometer and explain the construction.
2. Give the theory of Newton's ring and describe a method of producing them?
3. Describe briefly Young's double slit experiment?
4. Distinguish between Fresnel and Franhoffer diffraction?
5. What is meant by interference of light? Explain the conditions for production of interference fringes.
6. What is diffraction grating? How is it obtained?

Part C (10 Marks)

1. Explain Huygens's wave theory of light.
2. Using Young's double slit experiment, derive en expression for the bandwidth of monochromatic light.
3. Describe the construction and working of Michelson's Interferometer.
4. Explain how Newton's rings are formed and explain how this phenomenon can be used to determine the radius of curvature of a Plano-Convex lens?
5. Discuss the Franhoffer diffraction of a light at a single slit.

Unit V - LASERS

Part A (2 Marks)

1. What is absorption of light?
2. What is meant by population inversion?
3. What are the three important components of laser device?
4. What are the conditions required for laser action?
5. Mention the various types of laser?
6. What is the principle of laser action?
7. What is stimulated emission?
8. What is meant by optical resonator?
9. What is optical pumping?
10. What are the characteristics of laser?

Part B (6 Marks)

1. Compare the characteristics of laser with ordinary light
2. Write the difference between spontaneous and stimulated emission
3. Explain briefly the components of laser?
4. Mention the modes of vibration of CO_2 molecules
5. Write a short note on medical applications of laser
6. Mention the applications of laser in industry.

Part C (10 Marks)

1. Explain the construction and working of Nd-YAG laser with neat diagram
2. Explain the Einstein's relation between the stimulated emission and the spontaneous emission
3. Describe the construction and working of CO_2 laser
4. Explain the principle, construction and working of He-Ne laser
5. Explain the medical and industrial applications of laser

R. Velavan

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Bharath Institute of Science and Technology

B.Tech-Computer Science and Engineering (SEM I)

STUDENT PERFORMANCE RECORD

Course Name: Waves & Optics   Course code: U18BSPH101

Name of the Faculty : Dr. C. Rathika Thaya Kumari

S.No	Roll. No	Name	INT 1	INT 2	Assignmer	Att %
1	U19CS001	AADHISWARAN T	41	42	40	81
2	U19CS002	AAKAVARAM KIRAN	37	43	50	64
3	U19CS003	ABBURI SAMPATH KUMAR	37	42	45	91
4	U19CS004	ABDUL SHARUKH	44	41	50	86
5	U19CS005	ABHISHEK GANDEPALLI	A	37	40	77
6	U19CS006	ABHISHEK KUMAR SINGH	38	39	50	70
7	U19CS007	ABINAYA A	39	44	50	75
8	U19CS008	ACHAM SUKUMAR	36	35	50	81
9	U19CS009	ACHUTHA TEJA	38	A	40	85
10	U19CS010	ADABALA PUSHKAR RAMA	40	39	50	59
11	U19CS011	ADAPA KRISHNAVARDHAN	33	38	50	92
12	U19CS012	ADAPALA CHAITANYA NAG	38	38	45	97
13	U19CS013	ADAPALA CHUPAK PHANI S	41	39	50	90
14	U19CS014	ADDALA BHANOJ	43	39	50	70
15	U19CS015	ADDANKI CHINNARAO	32	34	50	78
16	U19CS016	ADEPU VENKATESH	38	33	45	90
17	U19CS017	ADHITHIYAN K	43	42	50	87
18	U19CS018	ADITHYA KANNAN K	40	36	45	64
19	U19CS019	ADITYA RAJ	38	34	50	84
20	U19CS020	T G S ADITYA	35	A	45	76
21	U19CS021	ADLA HASINI	33	28	45	74
22	U19CS022	ADLA PAVAN REDDY	45	41	40	62
23	U19CS023	ADUSUMALLI RAGA VENKA	35	32	50	78
24	U19CS024	AFKHAN NAWAZ KHAN	A	42	40	84
25	U19CS025	AIDA PRANEETH	36	36	50	73
26	U19CS026	AINALA KARTHIK	42	40	35	73
27	U19CS027	AISHWARYA J	36	30	50	66
28	U19CS028	AJAY KUMAR M	37	30	50	32
29	U19CS029	AKANIKSHA PARVATHANEN	38	38	50	82
30	U19CS030	AKASH S	37	A	50	77
31	U19CS031	AKASH T	39	44	50	44
32	U19CS032	AKULA VENKATESH	39	37	50	88
33	U19CS033	AKULA VINAYAK	37	31	50	90
34	U19CS034	AKUNURI KRISHNASAI	33	37	50	83
35	U19CS035	ALA ABHISHEK KUMAR	37	30	50	80
36	U19CS036	ALA NIKHIL KUMAR REDDY	40	39	40	71

37	U19CS037	ALAMURU LIKHITHA	42	43	50	85
38	U19CS038	ALAVALA SAI CHANDU	37	39	50	84
39	U19CS039	ALETI ANJI REDDY	40	39	50	84
40	U19CS040	ALLENKI USHA REDDY	41	35	50	80
41	U19CS041	ALLURI VIJAY	42	39	35	93
42	U19CS042	ALURI SANDEEP	40	45	50	83
43	U19CS043	ALUVALA KEERTHAN CHAN	33	35	40	89
44	U19CS044	AMANAGANTI VIKAS	35	37	50	85
45	U19CS045	AMARAVARAPU CHENNAKE	30	34	50	72
46	U19CS046	AMARAVARAPU NAGA VAM	38	34	50	82
47	U19CS047	AMARTYA KUMAR	39	42	50	82
48	U19CS048	AMBADIPUDI CHARETHARD	37	A	50	75
49	U19CS049	AMI REDDY VARSHITHA REI	40	39	35	63
50	U19CS050	AMRIT SAH	36	34	50	88
51	U19CS051	AMRITHA VARSHINI G	38	40	50	77
52	U19CS052	AMUDALAPALLI SIVAKIRAN	42	44	50	88
53	U19CS053	ANAGANI HARSHAVARDHAI	43	42	50	90
54	U19CS054	ANAKAPALLI CHANDRABAE	42	40	50	82
55	U19CS055	ANBARASU A	A	40	50	82
56	U19CS056	ANIMIREDDY GUNA SEKHAI	38	37	50	94
57	U19CS057	ANKAM VISHNUVARDHAN E	34	43	40	77
58	U19CS058	ANKIPALLI SIDDARDHA	31	32	50	90
59	U19CS059	ANMOL KUMAR SONI	42	41	50	70
60	U19CS060	ANNAM VAMSI	38	34	50	88
61	U19CS061	ANNAM YASWANTH	39	39	45	85
62	U19CS062	ANNAVARAPU ANIL	29	28	45	84
63	U19CS063	ANNE JAYA KRISHNA	45	44	50	84
64	U19CS064	ANNEBOINA RAHUL	43	A	50	80
65	U19CS065	ANTHAM ROHITH REDDY	40	36	40	93
66	U19CS066	ANTHATI UDAY GOUD	39	36	50	83
67	U19CS067	ARAMALLA	39	37	50	89
68	U19CS068	ARETI SUPRIYA	39	38	40	85
69	U19CS069	ARIGELA SRINIVASARAO	32	36	50	72
70	U19CS070	ARJUN J	39	34	50	82
71	U19CS071	ARRA SAI PRASANNA	34	34	50	82
72	U19CS072	ARROJU MANOJ KUMAR	38	39	40	75
73	U19CS073	ARRURI VENKATESH	42	A	50	63
74	U19CS074	ARUKONTHAM	44	41	50	88
75	U19CS075	ASLAM SAFIQ A	A	45	40	77

Bharath Institute of Science and Technology

Student Feedback Report - 2019 -2020 (Sem I)

Course Code: **U18BSPH101**

Course Name: **Waves & Optics**

Lecturer: **Dr. C. Rathika Thaya Kumari**

Reg No.	1	2	3	4	5	6	7	8	9	10
U19CS003	5	5	5	5	5	5	5	5	5	5
U19CS007	5	5	5	5	5	5	5	5	5	5
U19CS009	5	5	5	5	5	5	5	5	5	5
U19CS015	5	5	5	5	5	5	5	5	5	5
U19CS017	4	4	3	4	4	4	4	4	4	5
U19CS019	5	5	5	5	5	5	5	5	5	5
U19CS022	5	5	5	5	5	5	5	5	5	5
U19CS023	2	2	5	5	4	5	4	5	4	3
U19CS024	5	5	5	5	4	5	4	5	4	4
U19CS025	5	5	5	5	5	5	5	5	5	5
U19CS026	4	4	4	3	3	4	3	5	4	3
U19CS027	5	5	5	5	5	5	4	5	5	5
U19CS028	5	5	5	5	3	3	1	5	5	2
U19CS029	4	3	5	5	4	4	3	4	5	2
U19CS030	5	5	5	4	3	4	3	4	4	5
U19CS031	4	4	4	5	5	5	4	5	5	4
U19CS032	5	4	4	4	4	4	4	4	4	4
U19CS033	4	5	5	5	5	5	5	5	5	1
U19CS048	5	4	5	4	5	5	5	4	5	5
U19CS049	5	5	5	5	5	5	5	5	5	5
U19CS054	5	5	5	5	5	5	5	5	5	5
U19CS060	5	5	5	5	5	5	5	5	5	5
Average	**4.6**	**4.5**	**4.7**	**4.7**	**4.4**	**4.6**	**4.2**	**4.7**	**4.7**	**4.1**

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF PHYSICS – 2019 – 2020 (SEM I)

COURSE END SURVEY REPORT

COURSE NAME: WAVES AND OPTICS

COURSE CODE: U18BSPH101

CO ATTAINMENT – SURVEY REPORT						
COs	No. of 5's	No. of 4's	No. of 3's	No. of 2's	No. of 1's	CO %
CO1	25	27	16	4	3	90.7
CO2	22	28	17	6	2	89.3
CO3	23	20	23	6	3	88.0
CO4	20	28	19	3	5	89.3
CO5	18	24	21	7	5	84.0
CO6	21	20	19	5	10	80.0
Total	**129**	**147**	**115**	**31**	**28**	

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF PHYSICS

COURSE ATTAINMENT

COURSE NAME: WAVES AND OPTICS

COURSE CODE: U18BSPH101

Total CO Attainment											
		END SEMESTER EXAM									
CO	CO ATTAINMENT AVERAGE FROM ASSESSMENT TEST	MARKS ALLOTTED	MARKS OBTAINED	CO ATTAINMENT AVERAGE FROM END SEMESTER EXAM	DIRECT CO ATTAINMENT	INDIRECT CO ATTAINMENT (OBTAINED FROM EXIT SURVEY)	TOTAL CO ATTAINMENT (%)	TARGET [CLASS AVERAGE] (%)	CO ATTAINMENT GAP [TARGET - ATTAINMENT](%)	Actions Proposed to bridge the Gap (Gap >0)	Modification of Target when achieved(Gap <=0)
CO1	68	16	13	81	76	91	79	78	-1	Target Attained	Target Increased to 80
CO2	67	16	13	81	76	89	78	75	-3	Target Attained	Target Increased to 80
CO3	71	16	11	69	70	88	73	70	-3	Target Attained	Target Increased to 75
CO4	68	16	12	75	72	89	76	72	-4	Target Attained	Target Increased to 78
CO5	81	16	10	63	70	87	73	70	-3	Target Attained	Target Increased to 75
CO6	73	20	11	55	62	80	66	65	-1	Target Attained	Target Increased to 68

R. Velavan

Dr. R. VELAVAN, M.Sc., M.Phil., Ph.D.,
Professor and Head
Department of Physics
Bharath Institute of Higher Education & Research

BHARATH INSTITUTE OF HIGHER EDUCATION AND RESEARCH

DEPARTMENT OF PHYSICS

CO attainment through students Performance			
Year	I year (2019-20)	Semester	II
Subject code	U18BSPH101	Subject	Waves and Optics

Average Mark	75	71	73	68	96	93
No.of students above average	51	50	53	51	61	55
Total no. of students	75	75	75	75	75	75
% CO attainment	68.0	66.7	70.7	68.0	81.3	73.3

PO mapping against CO							Aver. PO attainment
	CO1	CO2	CO3	CO4	CO5	CO6	
PO1	3	3	3	3	3	3	74.33
PO2		3				2	73.20
PO3	2	2	2	2		3	73.82
PO5	1			1			77.50
PO10					3	3	69.50
PO12					2		73.00
%CO attai	79.0	78.0	74.0	76.0	73.0	66.0	

CO INDIRECT ATTAINMENT – SURVEY REPORT						
CO	No. of 5's	No. of 4's	No. of 3's	No. of 2's	No. of 1's	CO %
CO1	25	27	16	4	3	90.7
CO2	22	28	17	6	2	89.3
CO3	23	20	23	6	3	88.0
CO4	20	28	19	3	5	89.3
CO5	18	24	21	7	5	84.0
CO6	21	20	19	5	10	80.0
Total	*129*	*147*	*115*	*31*	*28*	

Department of Physics

Subject Name & Code: Waves and Optics - U18BSPH101 (2019-2020)

CO Attainment Score

S.No	Reg.No	Name	CO Attainment Percentage						
			CO1 %	CO2 %	CO3 %	CO4 %	CO5 %	CO6 %	Average
1	U19CS001	AADHISWARAN T	79	86	82	86	100	60	82
2	U19CS002	AAKAVARAM KIRAN	71	77	92	82	100	100	87
3	U19CS003	ABBURI SAMPATH KUMAR	78	73	82	86	100	80	83
4	U19CS004	ABDUL SHARUKH	86	91	79	86	100	100	90
5	U19CS005	ABHISHEK GANDEPALLI	0	0	75	73	80	80	51
6	U19CS006	ABHISHEK KUMAR SINGH	79	73	79	77	100	100	85
7	U19CS007	ABINAYA A	71	86	93	86	100	100	89
8	U19CS008	ACHAM SUKUMAR	79	68	79	64	100	100	82
9	U19CS009	ACHUTHA TEJA	71	82	0	0	100	60	52
10	U19CS010	ADABALA PUSHKAR RAMA SAI PRAVE	67	95	75	82	100	100	87
11	U19CS011	ADAPA KRISHNAVARDHAN NAIDU	60	73	89	64	100	100	81
12	U19CS012	ADAPALA CHAITANYA NAGA SAI	82	73	93	59	100	80	81
13	U19CS013	ADAPALA CHUPAK PHANI SAI	89	77	77	82	100	100	88
14	U19CS014	ADDALA BHANOJ	82	91	82	77	100	100	89
15	U19CS015	ADDANKI CHINNARAO	61	68	68	68	100	100	78
16	U19CS016	ADEPU VENKATESH	79	73	64	68	100	80	77
17	U19CS017	ADHITHIYAN K	96	77	93	77	100	100	91
18	U19CS018	ADITHYA KANNAN K	86	77	79	68	100	80	82
19	U19CS019	ADITYA RAJ	68	86	57	82	100	100	82
20	U19CS020	T G S ADITYA	79	64	0	0	80	100	54
21	U19CS021	ADLA HASINI	62	73	54	59	100	80	71
22	U19CS022	ADLA PAVAN REDDY	89	91	93	73	80	80	84
23	U19CS023	ADUSUMALLI RAGA VENKATA MANI KISHORE	86	55	64	64	100	100	78
24	U19CS024	AFKHAN NAWAZ KHAN	0	0	89	82	60	100	55
25	U19CS025	AIDA PRANEETH	64	82	64	82	100	100	82
26	U19CS026	AINALA KARTHIK	82	86	86	77	80	60	79
27	U19CS027	AISHWARYA J	86	59	64	59	100	100	78
28	U19CS028	AJAY KUMAR M	82	68	54	68	100	100	79
29	U19CS029	AKANIKSHA PARVATHANENI	68	86	79	73	100	100	84
30	U19CS030	AKASH S	68	82	0	0	100	100	58
31	U19CS031	AKASH T	75	82	96	82	100	100	89
32	U19CS032	AKULA VENKATESH	93	64	93	55	100	100	84
33	U19CS033	AKULA VINAYAK	89	59	74	50	100	100	79
34	U19CS034	AKUNURI KRISHNASAI	68	64	93	55	100	100	80
35	U19CS035	ALA ABHISHEK KUMAR	82	68	78	45	100	100	79
36	U19CS036	ALA NIKHIL KUMAR REDDY	86	77	79	77	80	80	80
37	U19CS037	ALAMURU LIKHITHA	86	82	86	86	100	100	90
38	U19CS038	ALAVALA SAI CHANDU	68	82	79	77	100	100	84
39	U19CS039	ALETI ANJI REDDY	86	77	79	77	100	100	87
40	U19CS040	ALLENKI USHA REDDY	93	73	79	64	100	100	85
41	U19CS041	ALLURI VIJAY	86	82	75	82	80	60	78
42	U19CS042	ALURI SANDEEP	89	73	96	86	100	100	91
43	U19CS043	ALUVALA KEERTHAN CHAND	79	55	82	59	80	80	73
44	U19CS044	AMANAGANTI VIKAS	81	59	75	73	100	100	81
45	U19CS045	AMARAVARAPU CHENNAKESAVA RAYUDU	81	41	64	73	100	100	77
46	U19CS046	AMARAVARAPU NAGA VAMSI	75	77	68	68	100	100	81
47	U19CS047	AMARTYA KUMAR	93	64	89	80	100	100	88
48	U19CS048	AMBADIPUDI CHARETHARDHA	69	82	0	0	100	100	59
49	U19CS049	AMI REDDY VARSHITHA REDDY	79	82	79	77	60	80	76
50	U19CS050	AMRIT SAH	71	73	57	79	100	100	80
51	U19CS051	AMRITHA VARSHINI G	68	86	75	88	100	100	86
52	U19CS052	AMUDALAPALLI SIVAKIRAN	82	86	93	86	100	100	91
53	U19CS053	ANAGANI HARSHAVARDHAN	96	77	89	82	100	100	91
54	U19CS054	ANAKAPALLI CHANDRABABU NAIDU	89	82	75	86	100	100	89
55	U19CS055	ANBARASU A	0	0	75	86	100	100	60
56	U19CS056	ANIMIREDDY GUNA SEKHAR	68	86	71	77	100	100	84
57	U19CS057	ANKAM VISHNUVARDHAN BABU	61	77	96	78	80	80	79
58	U19CS058	ANKIPALLI SIDDARDHA	68	59	86	45	100	100	76
59	U19CS059	ANMOL KUMAR SONI	82	86	89	77	100	100	89
60	U19CS060	ANNAM VAMSI	86	68	68	69	100	100	82
61	U19CS061	ANNAM YASWANTH	81	77	75	82	80	100	83
62	U19CS062	ANNAVARAPU ANIL KUMAR	82	36	46	67	100	80	69
63	U19CS063	ANNE JAYA KRISHNA	89	91	93	86	100	100	93
64	U19CS064	ANNEBOINA RAHUL GOUD	93	82	0	0	100	100	63
65	U19CS065	ANTHAM ROHITH REDDY	86	77	81	65	80	80	78
66	U19CS066	ANTHATI UDAY GOUD	75	82	71	73	100	100	84
67	U19CS067	ARAMALLA YASHWANTH REDDY	89	68	89	59	100	100	84
68	U19CS068	ARETI SUPRIYA	86	73	86	68	80	80	79
69	U19CS069	ARIGELA SRINIVASARAO	71	59	82	64	100	100	79
70	U19CS070	ARJUN J	84	73	74	64	100	100	83
71	U19CS071	ARRA SAI PRASANNA	75	64	68	73	100	100	80
72	U19CS072	ARROJU MANOJ KUMAR	82	73	89	68	80	80	79
73	U19CS073	ARRURI VENKATESH	86	82	0	0	100	100	61
74	U19CS074	ARUKONTHAM DEVENDER REDDY	93	86	79	86	100	100	91
75	U19CS075	ASLAM SAFIQ A	0	0	89	91	100	60	57
		Average:	75	71	73	68	96	93	