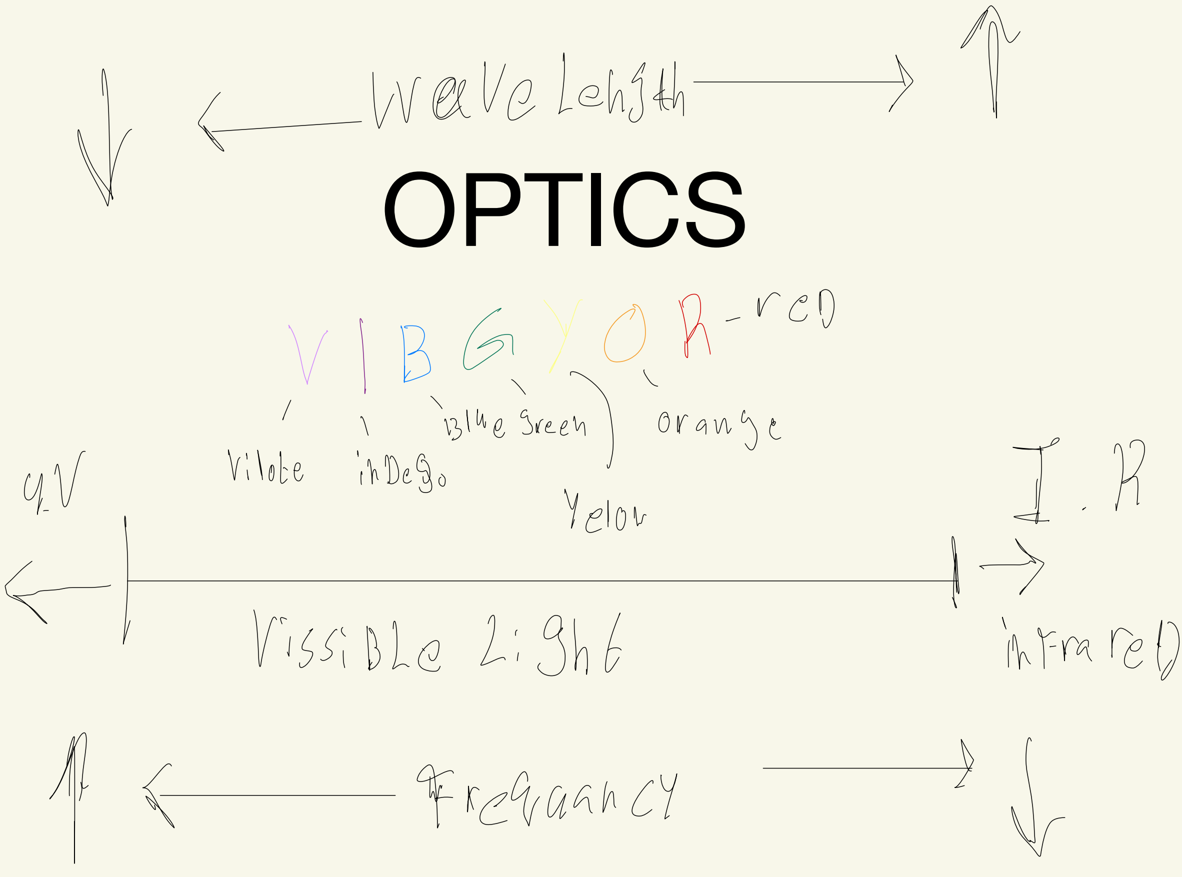
Abdulla Aljunibi

OPTICS



wave Length
VIBGYOR-red
Vilote
inDego
Blue
green
Yelow
orange
U.V
I.R
Vissible Light
infrared
Freqaancy

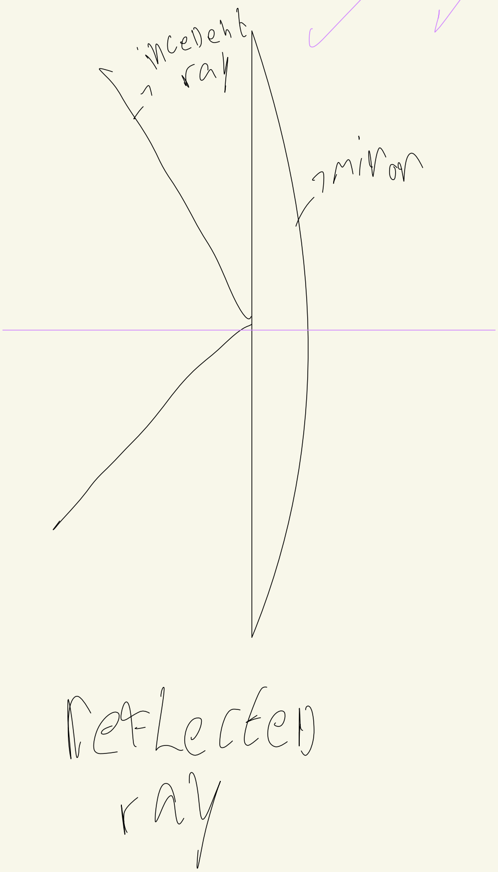
Speed of Light: 3×10^8 m/s

Speed of Light chang:

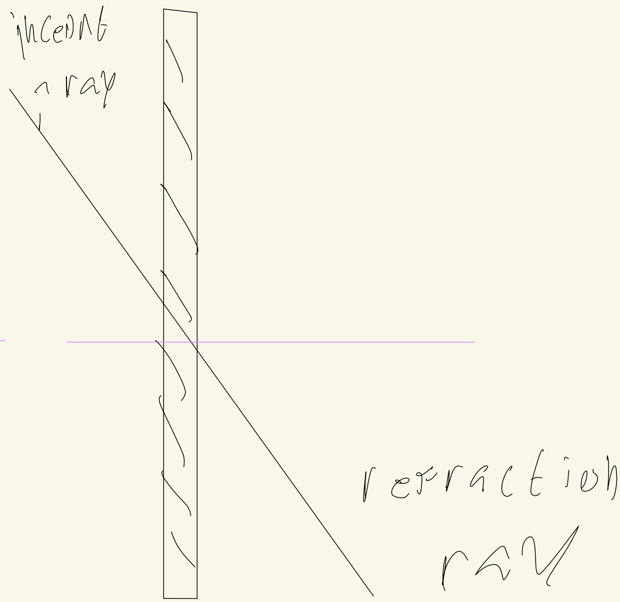
- with Difrent Dencity

Ex:

Reflection



Refraction



OPTICS

THE NATURE OF LIGHT

- Light is a form of electromagnetic radiation
- It is part of the wide spectrum of electromagnetic radiation that surrounds us at all times.
- Visible light is a relatively small part of the spectrum.

SPEED OF LIGHT

3×10^8 m/s

- Light is a type of wave
- the wave moves with a definite speed

The speed of light (c) is exactly :

- 299 792 458 meters per second which is 186 282.4 miles per second

It should be noted that this is the speed of light in a : vacuum

The passage of light through matter : reduces this speed

1, Materials have a refractive index (n)
2, which is the speed of light (c) in a vacuum divided by the speed of light through the material (v).

$n = \frac{c}{v}$

The refractive index of :

- air is : 1.000 29
- water is : 1.33
- glass is: 1.6

This means that :

- light travels slower through water than air and slower through glass than water

The wavelength of visible light is:

- usually measured in a unit called the Angstrom (A): 1A = 10^{-10} m

Various colors of visible light have : characteristic wavelengths
(every color have his own characteristic)

They also have : characteristic frequencies :

- since the frequency of light × wavelength = speed of light
- With symbols this is written $f\lambda = c$

Wavelengths of visible light

- Violet = 4 500 A
- Blue = 4 800 A
- Green = 5 200 A
- Yellow = 5 800 A
- Orange = 6 000 A
- Red = 6 400 A

REFLECTION

Reflection is :

- the change in direction of a lightwave when it strikes a different media
- that in which it was traveling so that the wave returns back into the original media.

Mirror-like reflection is called: specular reflection.

This can occur when the reflective surface is a material that suppresses the propagation of the light wave or in a material that allows the passage of light such as water or glass.

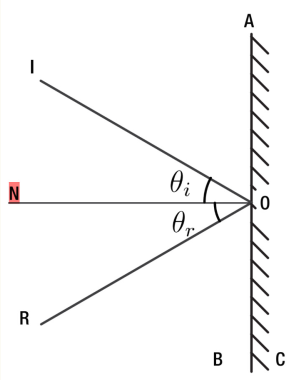


Figure 4-2. Specular reflection.

A perpendicular line drawn from the point where the light strikes the mirror is called the normal. The light striking the mirror forms an angle of incidence (0i) with the normal. The light reflected from the mirror also forms an angle with the normal called the angle of reflection (0r). It is a law of reflection that the angle of incidence is equal to the angle of reflection. Two further laws of reflection are: the incidence ray, the reflective ray and the normal at the point of incidence lie in the same plane, and the reflected ray and the incidence ray are on opposite sides of the normal.

angle of incident = angle of reflection

Law of reflection:

Reflection can occur off of a

- plane surface such as a typical flat mirror or piece of glass
- curved surface

When reflection occurs off of a flat surface:

- it is said to form a mirror image

When occurring off of a curved surface the image may be:

- magnified or demagnified

Most curved mirrors are spherical. They can be:

- convex (bulging outward toward the light source)
- concave (bulging inward away from the light source)

A convex mirror:

- reflects light outward and demagnifies the image
- It also provides a wider field of view.

A Convex mirrors:

- commonly used as passenger-side rear-view mirrors on automobiles.
- A concave mirrors focuses light when it reflects.
- a concave mirror is used so that it magnifies the image
- It can be found in telescopes and in make-up mirrors to gain a close look at one's face.

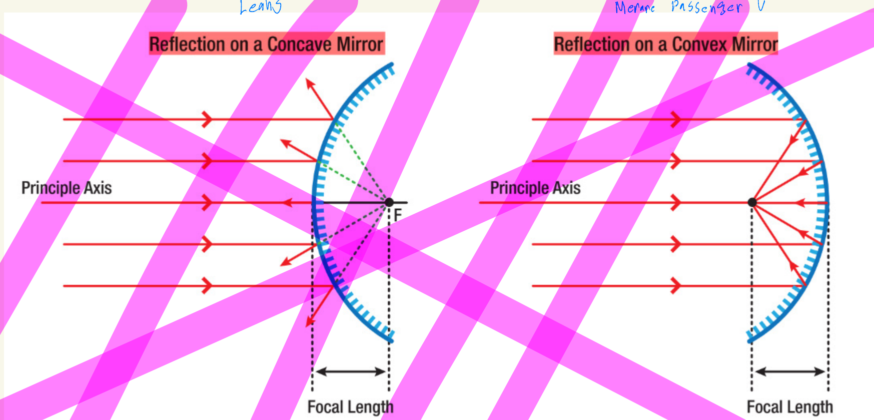


Figure 4-3. Reflection patterns of light on a concave and convex mirrored surface.

REFRACTION

Refraction is the:

- phenomenon observed when light changes direction due to it passing through a medium in which it travels at an altered speed.

When light enters a slower medium at an angle, its frequency:

- remains the same.

But as soon as part of the incoming light ray reaches a slower medium:

- its wavelength is shortened and the light bends towards the normal line.

The amount of bend depends of the :

- speed of light through the medium

The slower the speed = the more light will bend $n_1 \sin\theta_1 = n_2 \sin\theta_2$

- The higher the refractive index, the slower the speed of light through the material.

Snell's Law provides a mathematical equation for determining the angle that light will refract when passing from one medium through another:

$$\frac{n_1}{n_2} = \frac{\sin\emptyset_2}{\sin\emptyset_1}$$

- n1 is the index of refraction of the first medium
- n2 is the index of refraction of the second medium through with the light will pass and bend
- The angles are measured from the normal.

LENSES

lenses are developed to: focus light so that it is beneficial

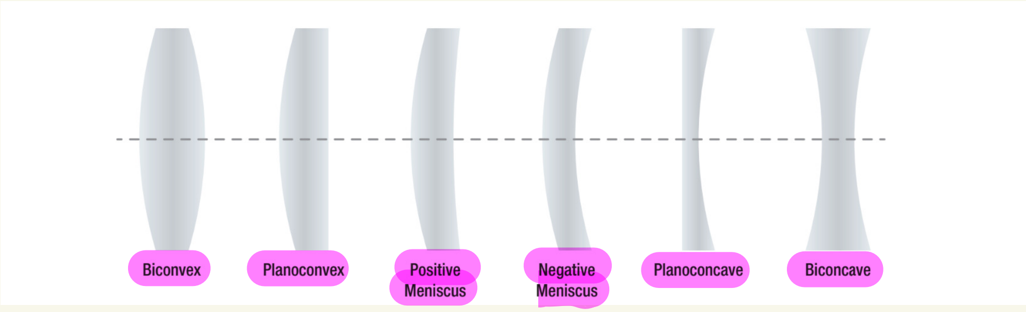
Eye glasses are made so that the incoming light will be corrected so that it focuses the image of the object being looked at directly on the retina of the eye. (human factors)

A lens can be defined as any device that:
- transmits and refracts light.

some lenses are constructed to:
- focus electromagnetic waves that are not visible light such as microwaves.

Compound lenses are :
- used to refine the focus and eliminate aberrations.

sample of different shaped lenses:



FIBER OPTICS = transmitting data

Fiber optics is the:
- branch of optical technology concerned with the transmission of light through fibers.

Electrical data is :
- converted to optical signals

and
- sent through optical fibers at the speed of light

The transmission of data through optical fibers offers: test question
- wide bandwidth
- light weight
- freedom from electromagnetic influence

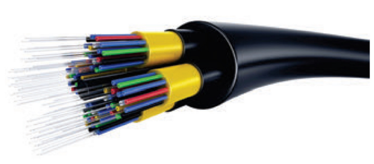


Figure 4-5. Fiber optic cable bundle.

CABLE CONSTRUCTION

fiber's cladding is usually coated with :
- a tough buffer layer which may be further : surrounded by a glass jacket layer.

These layers add:
- strength to the fiber but do not contribute to its optical properties

Fiber bundles:
sometimes put light-absorbing material between the fibers to :
- prevent light that leaks out of one fiber from entering another.

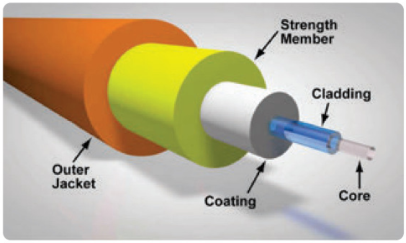


Figure 4-6. Construction of a fiber optic cable.

Fiber cable can be very: flexible

but

optical loss increases greatly if:

- the fiber is bent to a radius smaller than around 30 mm,

creating problems: if the cable is bent around corners or wound around a spool

Some fiber optic cables are :

- reinforced with glass yarns to : increase strength and also to protect the cable core against rodents and insects

FIBER MODES

Single-mode (or mono-mode) fiber has a :

- core diameter less than about ten times the wavelength of the propagating light

can process only a:

- single signal at a time.

Most single-mode fiber is designed for use in the:

- near infrared portion of the light spectrum

multi-mode fiber:

- a Fiber with a core diameter greater than 10 micrometers

multi-mode fiber:

- multiple rays of light are guided along the fiber core

by :

- the internal reflection of the cladding surrounding the fiber.

Each light pulse

- carries its own piece of data 1
- transmitted through the cable at different angles 2
- so as not to interfere with other pulses traveling through the same cable.
  at angles greater than the critical angle are completely reflected. 3

Rays that meet the boundary at a lower angle are refracted into the:

- cladding
- do not convey light or information along the fiber

Attenuation in fiber optics, also known as :

- transmission loss
- Meaning: the reduction in intensity of the light beam as it travels through the fiber medium

Attenuation is caused by:

- scattering
- absorption

→ is an important factor limiting the transmission of a signal across large distances.

TERMINATION AND SPLICING

Optical fibers are connected to terminal equipment by :

- optical fiber connectors

Standard connectors provide a:

- physical contact when:
- mating surfaces touch each other at an angled surface to :
- achieve the lowest possible attenuation and reduced reflections

A fiber-optic connector is basically a :

- rigid cylindrical barrel surrounded by a sleeve that holds the barrel in its mating socket typical connector is installed by:

- preparing the fiber end and inserting it into the rear of the connector body
- Quick-set adhesive is usually used to hold the fiber securely
- strain relief is secured to the rear.

Once the adhesive sets:

- the fiber's end is polished to a mirror finish

Optical fibers may be connected to each other by

- connectors
- or splicing

that is:

- joining two fibers together to form a continuous waveguide.

The generally accepted splicing method is known as :

- arc fusion splicing, which;
- melts the fiber ends together with an electric arc

In fusion splicing:

the two cable ends are fastened inside :

- splice enclosure and the fiber ends That are ;
- stripped of their protective coating and outer jacket
- The ends are cleaved with a precision cutter and are placed in the splicer

Splicer process: The splicer is a machine

1, The splice area is inspected with:

- magnified view screen to check the: cleaves before and after the splice

2, splicer emits:

- The splicer then : emits a small spark at the gap to burn off dust and moisture.

3, larger spark for fusion (bond the 2 ends)

- Then the splicer generates a larger spark that fuses the ends together permanently

4, optical loss measure:

The optical loss due to the splice is :

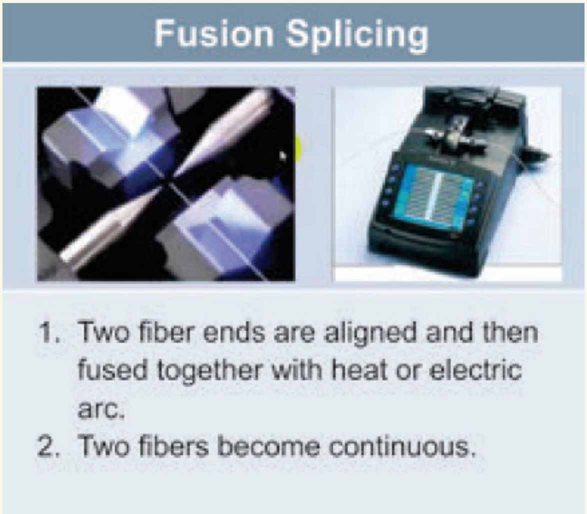
- measured by directing light through the cladding on one side

and

- measuring light leaking from the cladding on the other

5, splice loss:

- A splice loss of optical clarity under 0.1 dB is typical.



Mechanical splices

Mechanical splices are designed to be:

- quicker and easier to install

but:

there is still the need for :

- stripping
- careful cleaning
- precision cleaving

The fiber ends are:

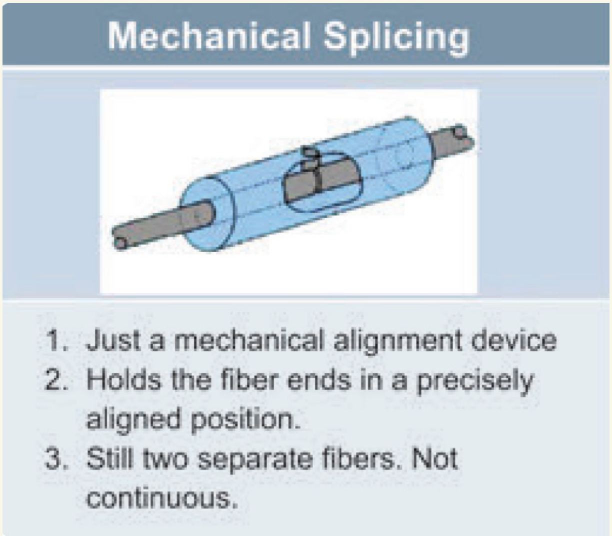
- clear gel that : enhances the transmission of light across the joint.

Mechanical splices typically have:

- higher optical loss
- and are less robust than fusion splices, especially if the gel is used.

Military aircraft have used fiber optics for heads up displays.

Figure 4-11. Fiber optic heads up display.



basic advantages of fiber optics

basic advantages of fiber optics for data transmission include:

1, System Performance
2, Greatly Increased Bandwidth and Capacity
3, Lower Signal Attenuation (Loss)
4, Immune to Noise (Electromagnetic Interference) and Radio-Frequency Interference
5, No Crosstalk
6, Lower Bit Error Rates
7, Signal Security
8, Difficult To Tap
9, Nonconductive Electrical Isolation (Does Not Radiate Signals)
10, No Common Ground Required
11, Freedom From Short Circuit and Sparks
12, Reduced Size and Weight of Cables
13, Environmental Protection
14, Resistant to Radiation and Corrosion
15, Resistant to Temperature Variation

Disadvantaged:

- high cost
- the reliability of connectors in the harsh aviation operating environments

FIBER OPTIC DATA LINK

Fiber optic data link is the name given to the system of components that use:

- optical fibers for the transmission of data.

1, Data is :

- input to a : transmitter

transmitter which :

- converts the electric signals into optical signals that ;
- directs them into the fiber.

2, The transmitter's:

- transmitter's drive circuit
- converts the electric signal to an optical signal by ;
- varying the electric current through the light source

3, LED's (light emitting diodes)

3, laser diodes

: are two common light sources employed.

4, connector:

- secure
- reliable
- durable

connector is required to join the transmitter and the fiber

5, remote end of the fiber

- At the remote end of the fiber, another connector joins the fiber to a receiver.
-

6, Receiver

- The receiver transforms the optical signal back into an electrical signal for use.

FIBER OPTIC DATA LINK

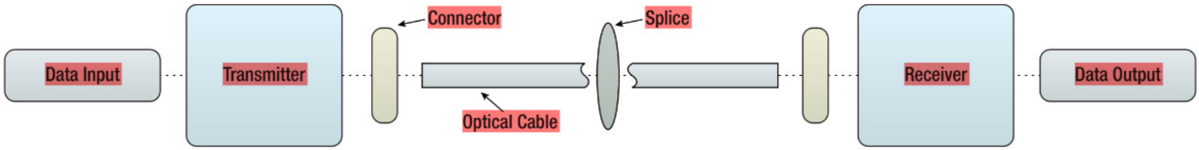


Figure 4-12. Typical components of a fiber optic data link.

General information

- the cost and availability of easy to manipulate, reliable and durable connectors have limited the use of fiber optics in aviation to this point. Conversely, the demand for high performance, bandwidth and weight savings free from electromagnetic interference is driving development of fiber optic use in aircraft