Experiment - 4: To Analyze the Attenuation losses in a Fiber using Optisystem 22

Date: - **08/02/25**

1. **Aim:** To Analyze the Attenuation losses in a Fiber using Optisystem 22
   a. To analyze the attenuation effect on a fiber with varying fiber length
   b. To analyze the effect of Stimulated Raman Scattering using four different wavelength Laser source

2. **Requirements:** Optisystem 22

3. **Pre Experiment Exercise:**
   Brief Theory

Optical fibers are a key component in modern communication systems, carrying signals over long distances. However, even the most advanced optical fiber suffers from attenuation, which is the loss of signal power as it travels along the fiber. In this blog, we'll explore what attenuation is, what causes it, and how it can be minimized.

What is Attenuation in optical fiber?
Attenuation meaning is the reduction of the signal power as it travels along an optical fiber. It's measured in decibels per kilometer (dB/km) and attenuation is caused by the absorption or scattering of light. A light signal traveling through the core of an optical fiber can be absorbed by impurities in the fiber or scattered outside the core by variations in the refractive index of the fiber. Over long distances, this attenuation can lead to a significant reduction in signal strength, making it difficult to resolve the original signal. Signal attenuation is a common issue in any communications system, regardless of the transmission medium. Excessive attenuation can result in degraded signal quality or complete signal loss. Several factors can contribute to attenuation, including distance, frequency, and transmission medium.

Types of Losses in Optical Fiber

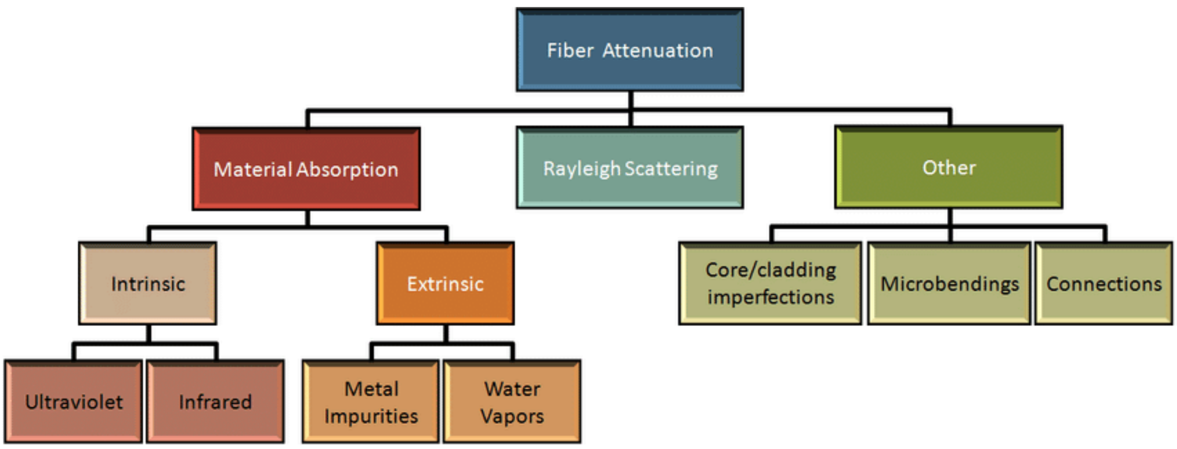

Fig. 1: Classification of factors contributing to signal attenuation in a fiber

Fiber loss, also called fiber optic attenuation or attenuation loss, refers to the loss of signal between input and output. Losses can be introduced by various means such as intrinsic material absorption, scattering, bending, connector loss and more. Losses can be divided into intrinsic and extrinsic types depending on whether the loss is caused by intrinsic fiber characteristics or operating conditions. Intrinsic Optical

Fiber Losses consist of absorption loss, dispersion loss and scattering loss caused by the structural defects or quality of the optical fiber core itself. Extrinsic Optical Fiber Losses originate from splicing loss, connector loss, and bending loss. Figure 1 shows a schematic of a fiber optic system with loss components.

Scattering: Scattering is the process by which some or all of the optical power is transferred into another mode. It occurs when light encounters a change in the refractive index of the medium. This can be caused by irregularities in refractive index of the fiber, impurities, particulates, or bubbles; or intrinsic, caused by fluctuations in the glass density, fiber axis direction composition, geometry or phase state.

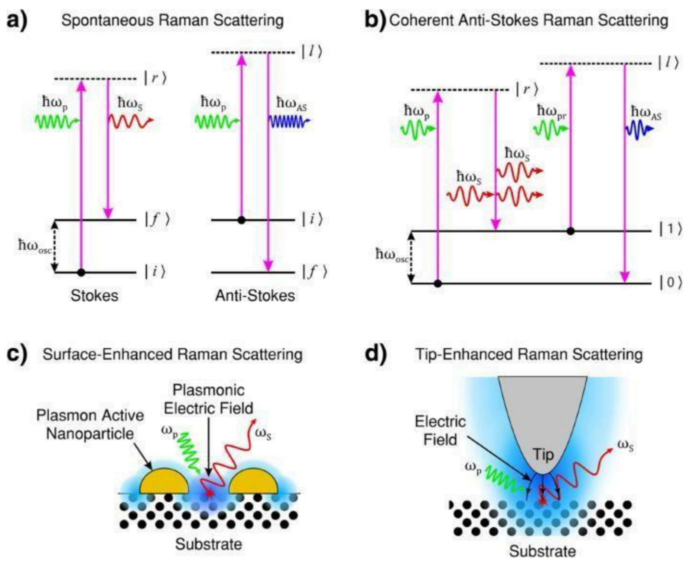

Fig. 2: Principle of Stimulated Raman Scattering

Stimulated Raman Scattering (SRS) occurs when a high-intensity light beam (pump beam) interacts with a material, causing its molecules to vibrate at a specific frequency, thereby generating a new light beam with a shifted frequency (Stokes beam) that is amplified significantly due to the presence of existing Stokes photons, effectively creating a cascade effect where more Stokes photons are produced as the pump beam propagates through the medium; this process is considered a nonlinear optical effect because the generated Stokes light is dependent on the intensity of the pump beam, exceeding the typical spontaneous Raman scattering intensity.

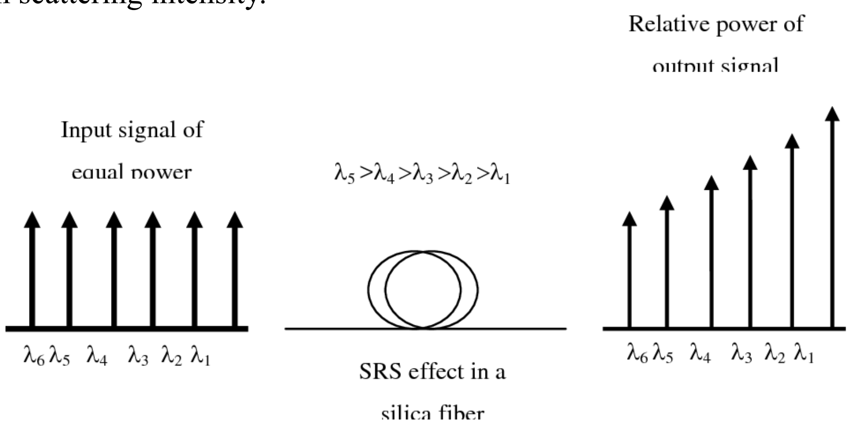

Fig. 3: Effect of Stimulated Raman Scattering

4. Procedure

Attenuation Effects in a fiber:

a. Connect the optical components as represented in the block diagram Fig. 4.
b. Vary the fiber length and measure the input and output power levels.

c. Tabulate the results and plot the relationship between attenuation and fiber length.
d. Repeat the procedure at wavelengths of 1300 nm and 1550 nm.

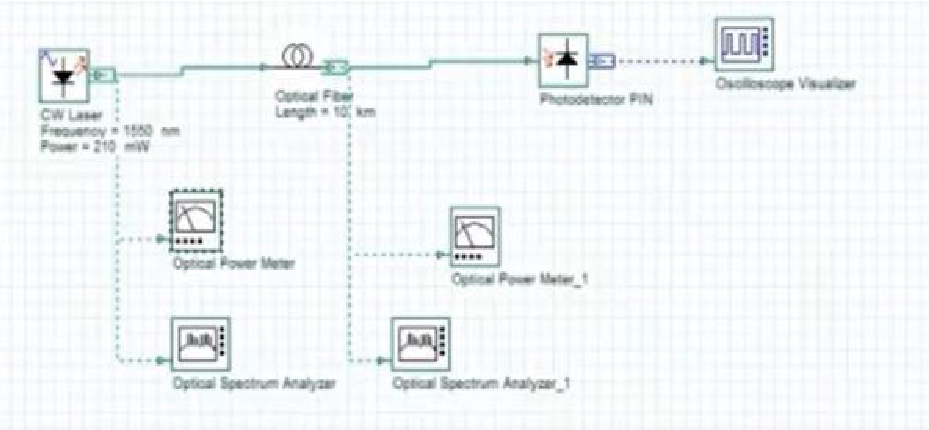

Fig. 4: Layout to demonstrate attenuation effect

SRS Effect in a fiber:

a. Connect the optical components as represented in the block diagram Fig. 5.
b. Plot the input and output spectrums using the analyzers.

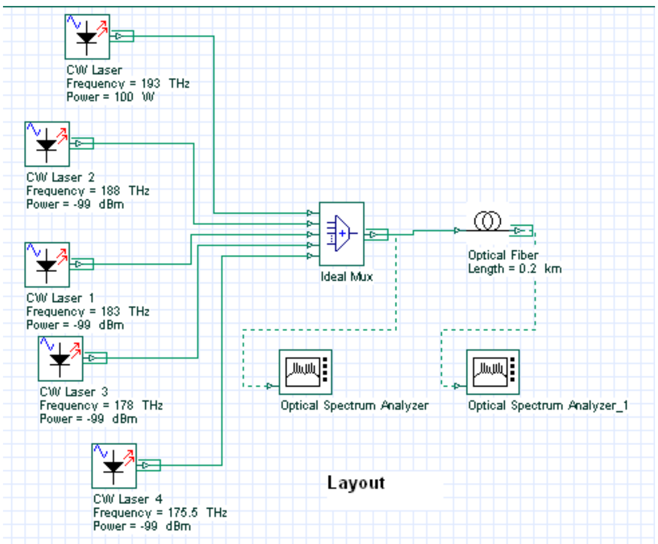

Fig. 5: Layout to demonstrate SRS effect

5. Observations:

a. Attach the simulated block diagram and graphical observations
b. Tabulate the attenuation effects:

At Wavelength: λ=1300nm Input Power P_i = 210mW

Length	Output Power P_o	Attenuation (α)	Alpha (L)
100	2.10E-03	0.2	20
200	2.10E-05	0.2	40
300	2.10E-07	0.2	60
400	2.10E-09	0.2	80
500	2.10E-11	0.2	100
600	2.10E-13	0.2	120

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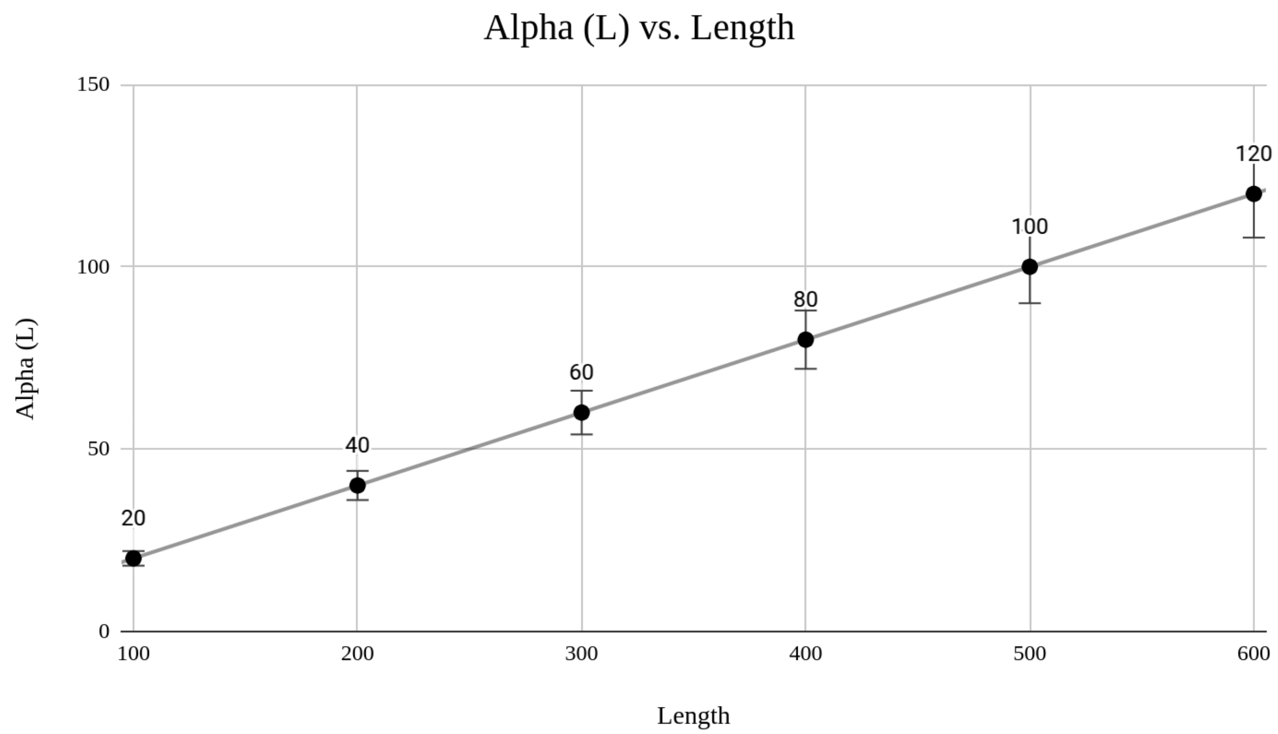
c. Plot the input and the output spectrum demonstrating the SRS effect.



6. Conclusion/Comments:

Comment on your observations on the basis of following points:

a. Effect of varying length of fiber on the attenuation:
b. Effect of source wavelength on fiber attenuation:
c. SRS effect (reduction and gain in power at different wavelengths):

7. Questions

1. Explain the various factors responsible for signal attenuation.
2. Differentiate between linear and non linear scattering
3. What are the optical windows and explain the significance of each.