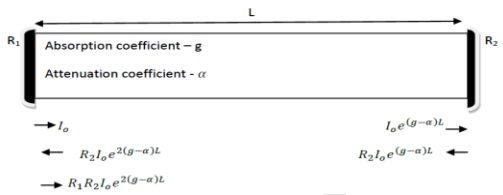
1. Derive an expression for the round-trip gain in a laser cavity.

**Answer:** Intensity after one round trip gain (a distance of 2L with the starting point as reference) is given by

$\boldsymbol{I = I_0 R_1 R_2 e^{2(g_o - \alpha)L}}$, where g and $\boldsymbol{\alpha}$ are the gain coefficient and loss coefficient respectively.




The amplification factor is then the ratio of the output intensity to the input intensity ($I_0$) and should be equal to $R_1 R_2 e^{2(g_o - \alpha)L}$.

If $\boldsymbol{R_1 R_2 e^{2(g_o - \alpha)L}} > 1$, oscillations can build up and the laser is said to be above the threshold. The threshold of laser oscillations is then defined by $\boldsymbol{R_1 R_2 e^{2(g_o - \alpha)L} = 1}$

$$\boldsymbol{g_{th} = \frac{1}{2L}(2\alpha L - \ln(R_1 R_2))}$$

2. What is the role of an optical resonator in a laser system?

**Answer**: Optical resonator/ laser cavity**,** is a crucial component in a laser system. It helps in

Feedback Mechanism:
It reflects light back and forth through the gain medium, allowing photons to stimulate further emissions — a process essential for amplification**.**

Mode Selection:
It supports only specific standing wave patterns (modes), helping determine the spatial and spectral characteristics of the laser output.

Beam Directionality and Coherence:
The resonator ensures that the laser emits a highly directional**,** coherent, and narrow-band beam of light.