Threshold Condition

- Rate of increase of stimulated photon intensity:

$$\frac{dI}{dt} = \left(N_2 - N_1 \frac{g_2}{g_1}\right) BhvI$$

On solving the equation we get: $I = I_0 e^{at}$; $where\ a = \left(N_2 - N_1 \frac{g_2}{g_1}\right) Bhv$

Now using: $t = \frac{x}{c'}$, $c' = \frac{c}{n}$ n = refractive index of the medium

c', c = velocity of light in medium and vacuum respectively.

x = position of wave at any time t

We get:

$$I = I_0 e^{kx} \quad ; \text{where } k = \left(N_2 - N_1 \frac{g_2}{g_1}\right) \frac{Bhvn}{c}$$

- Taking into account various losses with in cavity: $I = I_0 e^{(k-\gamma)x} R_1 R_2$

γ = total losses with in cavity; R_1, R_2= reflectivity of mirrors

Gain(G) is define as: $G = \frac{I}{I_0} = R_1 R_2 e^{(k-\gamma)x}$

Taking G =1 gives:

$$k_{threhold} = \gamma + \frac{1}{2L} \log\left(\frac{1}{R_1 R_2}\right)$$

Condition for LASER action(G >1 or $k > k_{threhold}$):

$$\left(N_2 - N_1 \frac{g_2}{g_1}\right) \frac{Bh\nu n}{c} > \gamma + \frac{1}{2L} \log\left(\frac{1}{R_1 R_2}\right)$$