PHYSICS ASSIGNMENT-4

Q1) Define the terms →

Sⁿ) (i) Stimulated Absorption:

When a photon of light having energy $h\nu = E_2 - E_1$ is incident on an atom in the ground state, the atom in the ground state E_1 may absorb the photon & jump to higher state E_2

This ~~photon~~ process is called stimulated absorption. Stimulated absorption because the incident photon has stimulated the atom to absorb the energy.

(ii) Spontaneous Emission:

Normally the excited state is an unstable state where the mean life of an atom is very short around 10^{-8} seconds.
Hence, the atom in excited state returns to ground state spontaneously, releasing a photon of energy $h\nu$.

This process is called spontaneous emission.

(iii) Stimulated Emission:

In this process an incident photon is absorbed by an excited atom as a result the atom becomes unstable & drops to ground state & hence, two photon are ~~released~~ released which are identical

in every way.
This process is called stimulated emission.

(iv) Pumping :

It is a process in which light is used to raise e^- from lower energy state to higher energy state.

(v) Meta Stable state :

It is an excited state of an atom or other system with longer life time than other excited states. However, it has shorter lifetime than other excited state.

(vi) Population Inversion :

It is the redistribution of atomic energy levels that take place in a system so that laser action can occur.

(vii) Active medium :

The active laser medium is the source of optical gain within a laser. The gain results from the stimulated emission of electronic or ~~nuclear~~ molecular transition to a lower energy state from a higher energy state previously populated by a pump source.

Q2) Find the relation b/w Einstien A & B coefficients

Soln) In thermal, equations at temp. T with radiatic frequency ν and energy density $u(\nu)$. let N_1 & N_2 be the number of atom in atoms electrons in energy state 1 & 2 respectively at any instant. The no. of atoms in state 1 absorb a photon & give rise to absorption per unit time for eq^n

$$P_{12} = P_{21}$$

$$N_1 B_{12}\, u(\nu) = N_2 \left[A_{21} + B_{21}\, u(\nu) \right]$$

$$u(\nu) = \cfrac{\cfrac{A_{21}}{B_{21}}}{\cfrac{N_1 B_{12}}{N_2 B_{21}} - 1}$$

According to Boltzmann distribution law

$$\frac{N_2}{N_1} = e^{-h\nu/kT} = \frac{N_1}{N_2} = e^{h\nu/kT}$$

Substituting $\dfrac{N_1}{N_2}$ in eq^n ① —

$$u(\nu) = \cfrac{\cfrac{A_{21}}{B_{21}}}{\cfrac{B_{12}}{B_{21}} e^{h\nu/kT} - 1} \qquad — ②$$

Acc. to planck's radiation Formulae

$$u(\nu) = \frac{8\pi h}{c^3} \cdot \frac{\nu^3}{e^{h\nu/kT} - 1} \qquad \text{—} \textcircled{3}$$

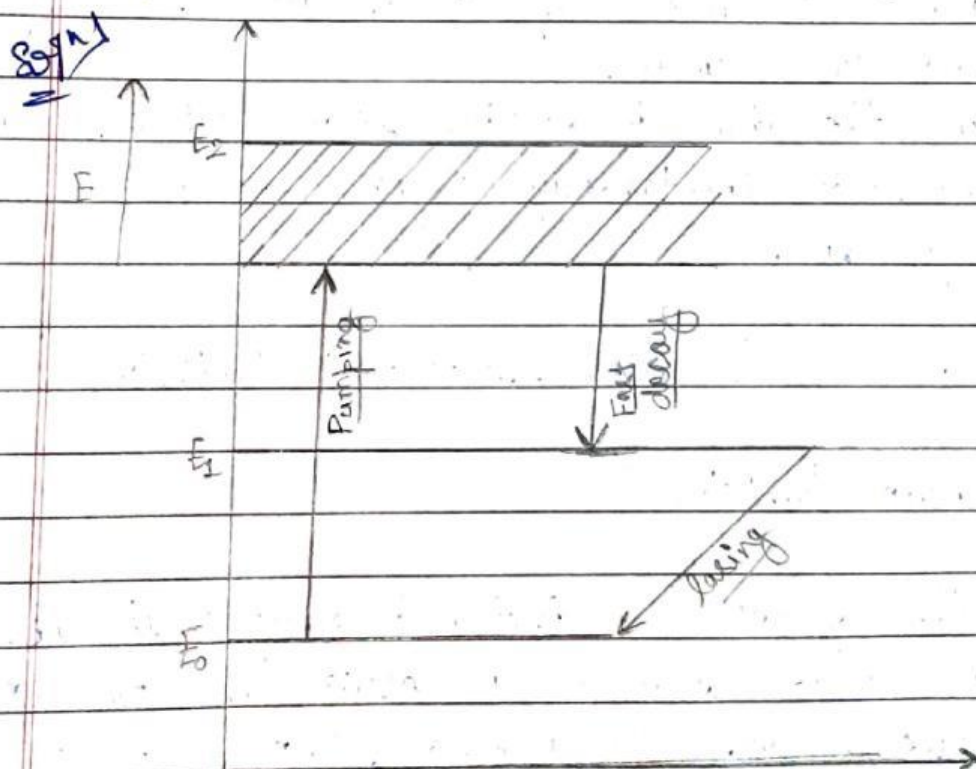Comparing eq^n ② & ③, we get

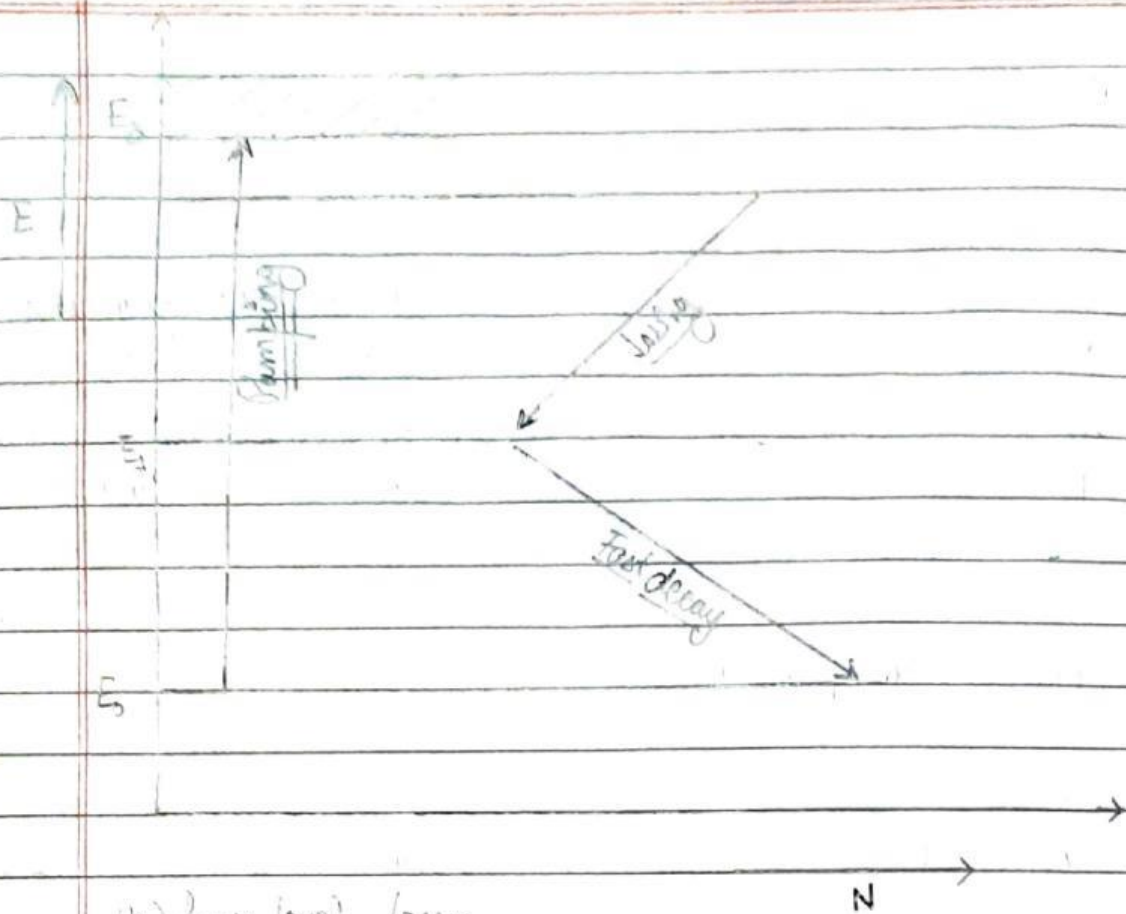$$\frac{B_{21}}{B_{12}} = 1$$

$$\boxed{B_{12} = B_{21}}$$

& $$\frac{A_{21}}{B_{21}} = \frac{8\pi h \nu^3}{c^3} \, e^{h\nu/kT}$$

Q3) Draw schematic diagram of three levels &
four level laser →

Sol^n)

(a) Three level laser
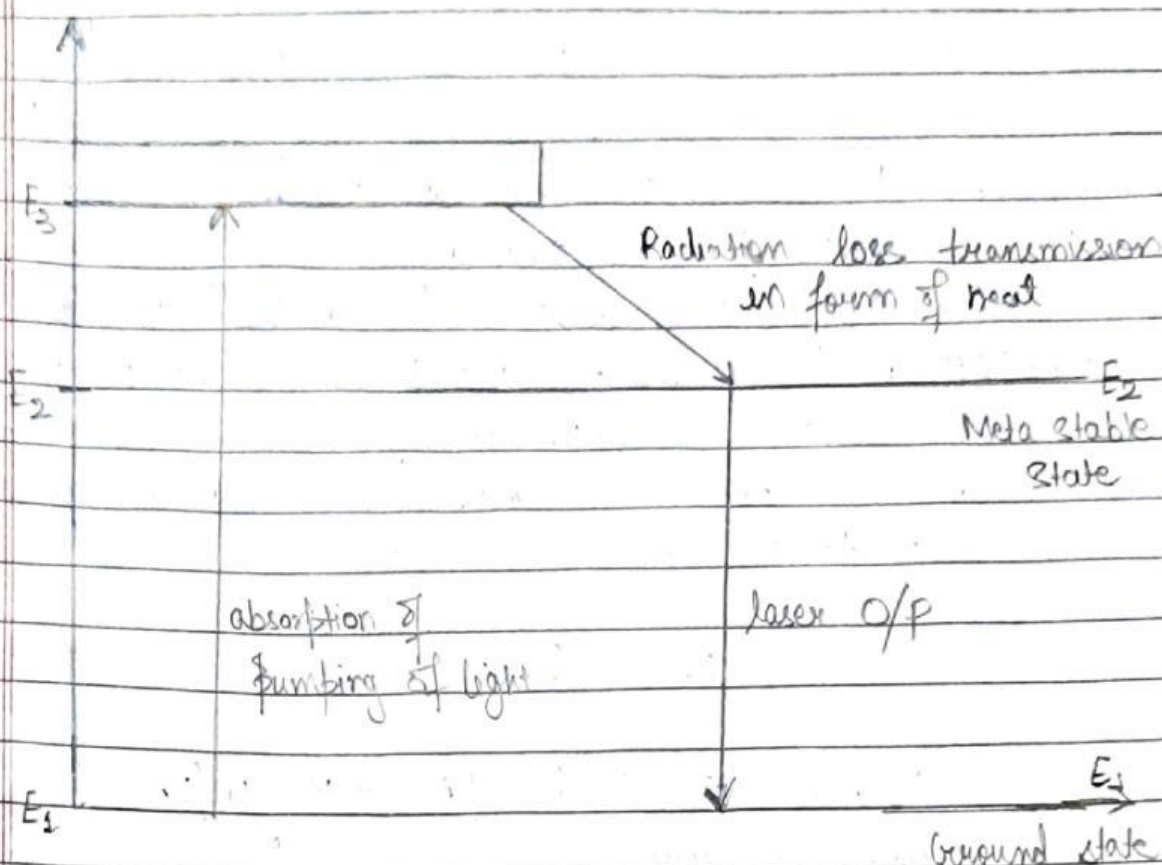
E↑

Pumping

Fast decay

N →

(b) four level laser

Q4) Describe the construction & working of a Ruby laser with necessary diagram.

Sol^n) The ruby laser consist of a Ruby Rod which is made of chromium doped ruby material. At the opposite ends of this rod there are two silver mirrors, whose one is fully polished and other one is partially polished. A ~~opening~~ spring is attached to the rod with fully polished end for adjustment of wavelength of laser light. Around the ruby rod a flash light is kept for the pump input. The whole assembly is kept in the glass tube. Around the neck of the glass tube the R.F source & switching control is ~~designed~~ designed ~~in~~ order to switch on and the flash light for desired intervals.

Radiation loss transmission
in form of heat

E_3

E_2 ———————————————— E_2
Meta stable
State

absorption of
pumping of light

laser O/P

E_1 ———————————————— E_1
Ground state

Energy level diagram