Tutorial Sheet-3

[Laser Technology and Applications, 16B1NPH533, Odd Semester 2020]

1. [CO 1] If energy levels 1 and 2 are separated by an energy E_2-E_1, such that the corresponding transition frequency falls in the middle of the visible range, calculate the ratio of the populations of the two levels in thermal equilibrium at room temperature.

   [Ans: 1.1577×10^{-38}]
2. [CO 1] The wavelength of emission is 600 nm and the lifetime is 10^{-6} s. Determine the coefficient for the stimulated emission.

   [Ans: 1.3×10^{19} m/kg]
3. [CO 1] For an optical source at thermal equilibrium (1000 K), having wavelength 500 nm, calculate the ratio of the number of spontaneous to stimulated emissions.

   [Ans: 5×10^{12}]
4. [CO 1] For the $2P \rightarrow 1S$ transition in the hydrogen atom, the wavelength of the transition is 121.5 nm. The lifetime of the $2P$ state for spontaneous emission is 1.6×10^{-9} s. Calculate the Eistein's A and B coefficients.

   [Ans: $6.25 \times 10^{8}\ s^{-1}$, 6.73×10^{19} m/kg]
5. [CO 1] The orange krypton line (λ=6058Å) has a coherence length of 20 cm. Calculate the line width in terms of wavelength.

   [Ans: 0.018Å]
6. [CO 1] The coherence time for the red cadmium line (λ=6438Å) is about 10^{-9} s. Estimate the Monochromaticity of the line.

   [Ans: 2×10^{-6}]
7. [CO 1] The sun rays subtends an angle of about 32'(32 minutes) on earth and fall at double slit arrangement with wavelength 5000 Å by using appropriate filter. What should be the separation between the two slits in order to obtain good contrast fringes on the screen?

   [Ans: 55.55μm]
8. [CO 1] Find the coherence length for white light source (400 nm to 700 nm).

   [Ans: 1.008 μm]
9. [CO 1] A laser beam has a wavelength of 720nm and aperture 5 mm. The laser beam is focused towards moon the distance of which from earth is 4×10^{8} m. Calculate (i) the angular spread and (ii) Axial (or Aerial) spread when the beam reaches to moon.

   [Ans: (i) 1.75×10^{-4} radian, (ii) $1.55 \times 10^{10}\ m^2$]