KFUPM
Department of Physics
Phys412

Homework # 1

Due on Tuesday, February 27, 2007

Problem 1

A typical commercial He-Ne laser emits light at a wavelength of 663 nm with frequency width of 1 GHz. Find the temporal coherence length of this laser. The frequency width of a laser can be reduced by some frequency stabilization techniques. What is the frequency width necessary to have a coherence length of 100 m?

Problem 2

The beam emitted for a typical commercial He-Ne laser has a circular shape and a radius of about 1 mm just outside the laser. Calculate the divergence of this beam. What will be the size of this beam 1 km from the laser?

Problem 3

The power of a He-Ne laser is typically 1 mW. Compare the brightness of a He-Ne laser with that of the sun. Also, compare the maximum achievable intensity at the focal plane of a lens from focusing the laser and the sun.

Problem 4

A cavity filled with a dielectric material of refractive index n has a very small opening. Show that the intensity of blackbody radiation per unit frequency I_ν emitted from the opening of a cavity is related to the energy density of the radiation inside the cavity per unit frequency ρ_ν by the following formula: $I_\nu = \frac{c}{4n}\rho_\nu$, where c is the speed of light in vacuum.

Problem 5

Find the average number of photons in a frequency mode with a wavelength of 500 nm due blackbody radiation at a typical room temperature of 300 K. What will be this number if the wavelength is 50 μm?