

**Thapar University, Patiala**  
**School of Physics and Materials Science**  
**UPH001 Physics**  
**Tutorial Sheet # 8 (Laser)**

1. A typical He-Ne laser emits light of 632.8 nm. How many photons would be emitted by a 1 mW He-Ne laser per second?
2. HeNe laser and Nd:YAG laser are respectively of power 1 mW and  $10^{12}$  W. Find their photon output, and compare with the thermal photon output,  $10^9$  photon/s, from a broadband thermal source.
3. The half-width of a laser source of wavelength, 543 nm, is 0.01 nm. Compute its coherence length and coherence time.
4. Calculate the temporal coherence length for mercury vapor lamp emitting in green portion of the spectrum at wavelength 546.1 nm with emission band width of  $\Delta\nu = 6 \times 10^8$  Hz.
5. The coherence times for an ordinary source of light and for a laser light are respectively 0.1 ns and 10  $\mu$ s. Deduce the corresponding frequency widths and coherence lengths. Also comment.
6. What is the angular spread of a laser, of wavelength, 0.85  $\mu$ m? Also find how far from us a heavenly body should be if the given laser forms on it a spot of size, 200 km. The aperture of the laser is 0.27 cm.

Useful data:

Boltzmann constant	$= 1.38 \times 10^{-23} \text{ J K}^{-1}$
Planck's constant	$= 6.624 \times 10^{-34} \text{ J s}$
Velocity of light	$= 3 \times 10^8 \text{ m s}^{-1}$
Average frequency of optical region	$= 6 \times 10^5 \text{ GHz}$