**COLLEGE OF ENGINEERING ROORKEE, ROORKEE**
**Autumn Semester 2014-2015**

**Subject: Physics** **Subject Code: TPH101**
**Laser & Maxwell's Equations** **Tutorial Sheet: 5**

## Numerical Problems

1. The coherence length for sodium light ( 5890A) is 3cm. Calculate (i) frequency, (ii) coherence time and (iii) the number of oscillations in the coherence length. Ans (i) $5.05 \times 10^{14}$Hz, (ii) $1 \times 10^{-10}$s and (iii) $5.09 \times 10^{4}$
2. Calculate the power per unit area delivered by a laser pulse of energy $4 \times 10^{-3}$J and the pulse duration is $10^{-9}$sec. when it is focused on a target of very small radius $1.5 \times 10^{-5}$m.
3. A laser beam has wavelength 720nm and aperture of radius 2.5m. This beam is sent to moon $4 \times 10^{5}$ km away from the earth. Determine the angular spread and the aerial spread on the moon. Ans $1.44 \times 10^{-7}$rad, $3.32 \times 10^{3}$ m$^2$
4. A 50 mW laser beam with aperture 5mm emits a laser light of wavelength 7000A. Calculate the aerial spread and the intensity of the image when the beam is focused by a lens of focal length 0.2m.
   Ans $0.584 \times 10^{-8}$m$^2$, $85.6 \times 10^{5}$watt/m$^2$
5. The solar energy that the earth receives on its surface is 1360 watt/m$^2$. Calculate the amplitudes of electric and magnetic fields at the earth surface. Ans. 1012.26 V/m, 2.687 amp-turn/m
6. If the magnitude of H in a plane wave is 1 amp/meter, find the magnitude of E for plane wave in free space. Ans. 376.72 V/m
7. Assuming that all the energy from a 1000 watt lamp is radiated uniformly; calculate the average values of the intensities of electric and magnetic fields of radiation at a distance of 4 m from the lamp.
   Ans. 43.29 V/m, 0.115 amp-turn/m
8. Calculate the depth of penetration $\delta$ at the frequency 71.6 MHz in aluminum. The related parameters for aluminum are: $\mu = \mu_0 = 4\Pi \times 10^{-7}$ N/ Amp$^2$ and $\sigma = 3.54 \times 10^{7}$ Seimen/m. Ans 10 µm
9. For sea water $\mu = \mu_0 = 4\Pi \times 10^{-7}$ N/ Amp$^2$, $\varepsilon = 70\varepsilon_0$ and the conductivity $\sigma = 5$ S/m. Find the skin and attenuation constant for sea water. Ans 0.0038 m, 112.36 Np/m

### Theoretical Questions:

1. What is LASER? What are the requirements for producing laser action? How are they achieved?
2. Describe the construction and working of ruby laser. Give the properties and applications of laser.
3. Describe the construction and working of helium-neon laser. How is it superior to ruby laser?
4. What are the Einstein's coefficients A and B? Establish a relation between them.
5. Write the Maxwell's equations in integral as well as in differential form and explain their physical significance.
6. Show that the velocity of plane electromagnetic waves in the free space is given by $c = 1/(\mu_0\varepsilon_0)^{1/2}$.
7. Drive and explain Poynting theorem.
8. Write down Maxwell's equations in conducting medium and using these equations drive wave equation for both electric and magnetic fields.
9. Define penetration depth. Derive expressions for skin depth for good conductors.
10. Show that the electro magnetic waves are transverse in nature.
11. Electric and Magnetic vectors are mutually perpendicular in to each other and to the direction of propagation of wave vector.