



INDIAN INSTITUTE OF TECHNOLOGY PATNA
DEPARTMENT OF PHYSICS
Patliputra Colony, Patna – 800 013, India
End – Semester Examination
PH201: OPTICS AND LASERS

Date: 21 – 04 – 2015

Duration: 3 hours (Evening Session)

Maximum marks: 40

Attempt all Question

1. Consider a monochromatic beam of wavelength 600 nm incident normally on a scanning Fabry-Perot interferometer with $n_2 = 1$ and $F = 400$. The distance between the two mirrors is written as $h = h_0 + x$. With $h_0 = 10$ cm, calculate the first three values of x for which we will have unit transmittivity and the corresponding values of m . [5]
2. Prove that when the angle of incidence corresponds to the Brewster angle, the reflected and refracted rays are at right angles to each other. [3]
3. Calculate the state of the polarization of the emergent beam when a right circularly polarized beam is incident on a calcite half wave plate. [2]
4. (a) Why semiconductor laser diodes are used in optical communication?
(b) How digital electronic signals are converted to light signals using diode Lasers?
(c) Give an outline of typical fibre optical communication system? What are the advantages? [1+2+2]
5. Obtain the Ray transfer matrix (ABCD) for light propagation in free space between two points in space? (Let d be the distance between two propagation points, h is the height and θ is the angle). [1]
6. (a) Prove that photon flux density increases exponentially inside a gain medium which has population inversion
(b) How an optical amplifier is converted into an optical oscillator? How sustained oscillations of photons are maintained inside the Laser? [3 + 2]
7. Show that Photon energy density $\rho(v)$ and Intensity $I(v)$ are related as $\rho(v) = I(v) / c$ [2]
8. A laser cavity is composed of 2 mirrors which are at a distance of d apart. The gain medium inside the laser cavity has a length of L . n_c and n_L are the refractive indices in space and in the gain medium respectively. After m passes through the amplifier the gain could overcome the loss inside the cavity. What is the time taken for this process? [2]
9. Consider an optical pump at 940 nm for a Yb:YAG crystal placed in a laser cavity.

[PTO]

The wavelength of ytterbium is 1030 nm. If all the photons emitted by the pump are absorbed by the crystal and used for the lasing process, calculate the maximum power output. The pump power is 1 W [2]

10. A resonator is composed of two mirrors, one concave and one convex, with radii of curvature 1.5 m and -1 m, respectively. The length of the resonator is L. In what range we could choose L such that the cavity remains stable. [1]

11. (a) Explain single mode and multimode operations of a laser (b) Why Laser output is spatially coherent? (c) Why LED have larger spectral width compared to LASER ? [2+1+2]

12. (a) Explain the components and working principle of Nd YAG Laser?
(b) The Nd YAG Laser operates at a wavelength of 1064nm. Is it possible to generate a light at double its frequency? Explain the technique and principle
(c) What is Phase conjugation? How a diverging beam becomes a converging beam after reflecting from a phase conjugate mirror? [3+2+2]