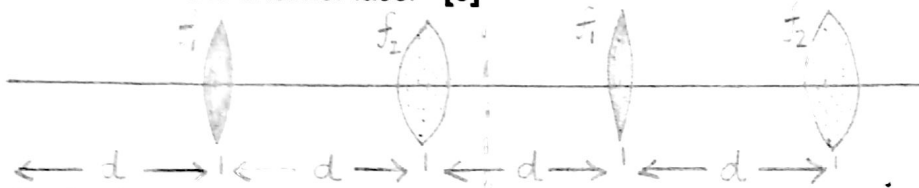# DEPARTMENT OF PHYSICS
EPL 334: LASERS

Major
Duration: 2hrs

Max. Marks 40
Nov20, 2015

Answer all questions.
Good Luck !!!

1) A periodic system comprises a sequence of lens pair with alternating focal length f_1 and f_2. Derive the condition of ray stability through this system.
   Mention two uses of the excimer laser **[5]**

2) Explain the basic principle behind the gas dynamic CO_2 laser with the help of a diagram. A two mirror resonator is formed by a convex mirror of radius $R_1 = -1m$ and a concave mirror of radius $R_2 = 1.5m$. What is the maximum possible mirror separation if this is to remain a stable resonator. **[5]**

3) Nd: YAG, is a crystal of $Y_3Al_5O_{12}$ in which Nd^{3+} replaces Y^{3+}. The typical atomic concentration used is 1%. Calculate the Nd^{3+} concentration in the ground state ($^4I_{9/2}$ level). This level is actually made up of five (doubly degenerate)levels. The four higher levels are spaced from the lowest level by 134, 197, 311 and 848 cm^{-1}, respectively. Calculate the Nd^{3+} concentration in the lowest level of the $^4I_{9/2}$ level. **[5]**

4) Explain amorphous crystal broadening with the help of a diagram.
   An Ar+ ion laser has a resonator of length 100cm. The refractive index is n=1. What would be the resonator length to achieve single longitudinal mode operation? What would be the length to realize the same in a CO_2 laser? **[5]**

5) Why is Ar+ ion laser inherently inefficient?
   Which are the mechanisms used in the creation of population inversion in a KrF excimer laser? **[5]**

6) Compare the Nd: YAG laser with the Nd:Glass laser. What are the processes involved in populating the upper laser level in a CO_2 laser **[5]**.

7) What are the inherent problems in a semiconductor homojunction laser? How are they overcome in a double heterostructure junction semiconductor laser? **[5]**

8) Write down the transparency condition for a semiconductor heterojunction laser with a lattice constant of 0.56nm. The wavelength for laser transition from the bottom of the conduction band is 670.7nm.
   What are VT and VV relaxations in a CO_2 laser? **[5]**

Mass of the hydrogen atom: 1.67×10^{-27}kgs
Planck constant: 6.62×10^{-34}J-s.
YAG Density: 4.56 gm/cm^3
Velocity of light: 3×10^8m/s
Doppler broadened linewidth in Ar ion laser: 3.5 GHz, CO_2 laser: 60 MHz

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