Problems in laser physics

Sheet 9

Handed out on 25. 1. 18 for the Tutorial on 8. 2. 18

Problem 25: Brewster Prisms (4P)

A Brewster prism is a symmetric prism designed for a special prism material and wavelength, so that the incoming and exiting rays are incident onto the prism surfaces at Brewster's angle $\theta_B = \arctan n$.

(a) Sketch a setup of a Brewster prism and the path of the ray. (1P)

(b) Show that the internal angles of the prism at its edges have to be (2P)

$$\delta = \theta_B \quad \text{and} \quad \gamma = 180^\circ - 2\theta_B \ . \tag{1}$$

(c) Show that the total angular deviation between the input and exit ray is given by (1P)

$$\alpha = 4\theta_B - 180^\circ \ . \tag{2}$$

Problem 26: HeNe laser (4P)

A HeNe laser consists of a $1\ \mathrm{mm}$-diameter bore discharge capillary with a length of $300\ \mathrm{mm}$ and is enclosed by two dielectric mirrors with 99.9% and 98% reflectivity, respectively.

(a) Calculate the optimum pressure range for the gas filling. (1P)

(b) Calculate the optimum He and Ne atomic densities for the case of a $632.8\ \mathrm{nm}$ laser and a $1152.3\ \mathrm{nm}$ laser at $T = 300$ K. (2P)

(c) Calculate the logarithmic gain $\ln G$ of this laser and the gain cross section for an inversion of $1.22 \times 10^9\ \mathrm{cm}^{-3}$. (1P)

Problem 27: Flashlamp-pumped Nd:YAG laser (4P)

In a Nd:YAG laser welding system a four-mesh transmission line is used in the power supply for two flashlamps connected in series. For this application, a pulse width of $t_p^* = 6\ \mathrm{ms}$ is necessary. The charging voltage is $U_0 = 900\ \mathrm{V}$ and a peak current of $450\ \mathrm{A}$ has been measured.

(a) Calculate the characteristic impedance Z of the network and the K_0 factor of one of the flashlamps in the case of impedance matched operation. (1P)

(b) Calculate the necessary capacity and inductance of the network's meshes from the impedance and the pulse width. What is the rise time of the current pulse. (2P)

(c) In practice, capacitors and inductors of $700\ \mu\mathrm{F}$ and $680\ \mu\mathrm{H}$ each have been used in the power supply. Calculate the characteristic impedance of the real network, the total pulse energy and the optimum capacity value resulting from E, K_0 and t_p^*. (1P)