

OC Problem Set 7

Friday, June 12, 2015

Problem: Dynamics of a Laser Diode

DC Characteristics:

- a) Give the rate equations and explain the various terms.
- b) Draw the DC characteristic for optical output power and carrier concentration qualitatively for $Q \rightarrow 0$. Mark currents for threshold I_S and (qualitatively) transparency I_t . Give the reason why $n_T = \text{const}$ for $I > I_S$. How would the threshold value change if the mirror reflectivities $R_{1,2}$ are increased?

Small signal modulation:

- c) What does the damping constant γ_r depend on, and how can it be manipulated?

Large signal modulation:

- d) Explain where the time delay t_d arises from when turning a laser on ($I_{\text{off}} = 0, I_{\text{on}} > I_S$), cf. Fig. 3.24.
- e) (Optional:) In part d), the laser is controlled by a current source. Could a voltage control reduce the time delay t_d during turn-on procedure?
- f) Explain what is meant when referring to relaxation oscillations. Where is the maximum of the photon number located at with respect to the value of the carrier concentration n_T ? Give the reason.
- g) How can the time delay be avoided, and how can the relaxation oscillation be mitigated?
- h) Explain the term amplitude-phase coupling, and explain where it arises from.

For questions and suggestions on the OC tutorial please contact:

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