NAME OF THE SCHOLAR Firas Sabeeh Mohammed
NAME OF SUPERVISOR Dr. A.K.Hafiz
DEPARTMENT Physics Department
TITLE OF THE THESIS Study the Instabilities in an External Cavity Diode Laser System

ABSTRACT

Semiconductor lasers are very attractive devices from the scientific point of view. The dynamics of their intensity output are very rich and suitable to study. A solitary semiconductor laser can be easily influenced by external perturbations, which can be introduced in the system by many different procedures. Pumping modulation, optical injection and optical or electro-optical feedback are the most extended ways to perturb the laser and force it to operate away from the constant-intensity (continuous wave, CW) state, Bi-stability, excitability, and many different types of nonlinear dynamics can be reproduced just by using an external mirror or injection light from another laser.Diode lasers operated with feedback have found applications in a number of areas due to the improvement that the feedback can lead to in many of the operating characteristics of the solitary diode laser.]. A source for coherent optical communication systems and spectroscopic applications is required to be single frequency, narrow linewidth, and continuously tunable over a wide range of wavelengths. There are many spectroscopic techniques for which diode lasers with feedback are ideal sources .Chaotic output may be used to provide secure optical communications. In this Thesis we are concerned about the study of the semiconductor laser with optical feedback, understood as a nonlinear optical system. We focus in the low-frequency fluctuation among other possible dynamics exhibited by this kind of laser. Investigate the stabilizing effects of a second optical feedback accompany with temperature effect. Where second optical feedback has been has been poorly investigated. Numerous laser-diode system

designs have been suggested. The system consists of three major parts, Laser Mount, Temperature Controller unit and Current Controller unit. A stabilized diode laser system has been successfully implemented using current and temperature controllers and appropriate laser mount. This system can be easily realized with very low cost. The electronic circuitries of the controllers are not only simple but easily comprehensible. The system is seen to provide temperature regulation from 5°C to 40°C, within an accuracy of ±0.05°C. Successful control results show high performance laser diode system. The fluctuations in the optical laser intensity were successfully suppressed by using our controller. Furthermore, the current controller shows high stability within an accuracy of ±0.01mA. We have experimentally analyzed the characteristics of the solitary diode laser and in presence of single optical feedback under the effect of temperature. The results obtained show dependence of the threshold current value on the temperature. High temperatures contribute to reduce the instability, this is cause increases the threshold current because height (potential barrier) afterward increases (band gap) which causes weakening the spontaneous emission to the advantages of stimulation emission. A semiconductor laser with external cavity can be stabilizing laser oscillation, by adjusting properly both the length and the feedback strength of the second external cavity. This was successfully demonstrated experimentally. Furthermore, the laser shows less stable oscillations at lower temperature values compared with stable fixed state at the higher temperature values.

By the introduction of the second mirror in anti-modes are separated far away from the oscillation modes and the laser does not show catastrophic oscillations like LFFs. The laser has stabilized in the maximum gain mode as a result, the line width of the laser oscillation becomes narrow, single mode and low intensity noise.