NAME OF SCHOLAR Tho-Alfiqar A. Zaker
NAME OF SUPERVISOR Dr. A.K.Hafiz
NAME OF CO-SUPERVISOR Prof. Zahid H. Khan
DEPARTMENT Physics Department/Faculty of Natural Sciences/JMI
TITLE OF THESIS Carrier Dynamics in Quantum-Well Lasers in Magnetic Field

ABSTRACT

The shift, which occurs in the output characteristics of semiconductor lasers in magnetic field, especially oscillation wavelength, has been the subject of great interest since the early 1960's. However, this research has only been made at very low temperatures and in very high magnetic field, which was well accounted for, in terms of Landau levels. In this thesis, experimental investigations were carried out to study the dynamical behavior of charge carriers in a relatively weak magnetic field (up to 2 Tesla) at room temperature by using a recently developed AlGaInP index guided Multiple Quantum-Well (MQW) laser operating around 670 nm. Experimental setups were designed and implemented to obtain electrical and spectral characteristics. We studied the influence of magnetic field on the electrical characteristics (Light versus Current and Voltage versus Current). Important parameters of the relevant laser device were studied for a wide range of temperature (5 - 45°C) in the presence and absence of magnetic field (up to 2 Tesla). We considered both cases for magnetic field B parallel and perpendicular to the quantum well planes (B//n and B⊥n, respectively). With the change in temperature, an average increase of 0.187 mA/°C was observed in the threshold current was observed. By applying the magnetic field parallel to the quantum well planes, the Light versus Current curves shifted to the high threshold current side. The effect was small when we applied the magnetic field perpendicular to the quantum well planes. The external differential quantum

efficiency decreased with the increase in temperature. The value of the characteristic temperature was found to increase on application of the magnetic field parallel to the quantum well planes. The observed changes in the threshold current with magnetic field were investigated. As the magnetic field was increased from 0 to 2 Tesla, the threshold current increased from 22.86 mA to 23.23 mA for B//n. In the case of B⊥n, the effect of magnetic field was very small. In general, the optical output power was found to decrease with the increase in the magnetic field. In the case B//n, the output power drops sharply with the increase in magnetic field, while for B⊥n, it drops only slightly.

Using lock-in amplifier and monochromator we studied the spectral characteristics of the laser. The influence of temperature, injection current, and magnetic field is observed on the optical emission spectra of the laser diode. The oscillation wavelength shift of the laser is also studied in detail. We have noticed d a red shift and a decrease in the peak intensity of the spectrum and the linewidth reduction under certain magnetic field condition. The amount of wavelength shift depends on the injection current, and on the strength and direction of the magnetic field. When magnetic field is applied parallel to the quantum well planes (B//n), a change in the oscillating wavelength of the order of 0.1nm was observed for B=1.9 Tesla. In the case of B⊥n, the shift was insignificantly small. In our study we present a new insight into the mechanisms that influence changes in the properties of MQW laser on application of magnetic fields based on the dynamics of electron-hole recombination.