The semiconductor laser is an important light source for high bit-rate fiber optics communications and integrated optics systems. Circuit simulation could be a powerful tool for the design and analysis of relatively complex circuits such as the semiconductor laser in combination with the driver circuitry. In this thesis, a new circuit model for the multimode semiconductor laser has been developed and simulated using the circuit simulator PSPICE. The model is used to study the effect of pulse broadening due to fiber dispersion. It is shown that eye diagrams can be generated from the models and can be used to assess the overall performance of high speed digital links. Intensity and frequency chirp waveforms are obtained from the circuit model developed from the chirp rate equations and the effect of gain compression parameter $\epsilon$ has been studied.

A circuit model for quantum well lasers based on the rate equations has been proposed. This model in conjunction with the optical fiber and photodetector model constituting an optical link has been validated by performing simulations. In addition, eye diagrams are generated for different pulse formats that are commonly used in fiber optic systems.

Circuit models for gain-switched quantum well lasers have been developed and pico-second pulses of 7 and 2 psec full width at half maximum for the second and third quantised state transitions respectively have been observed by simulating the models. Effects of cavity length and number of wells on the output pulse shape have been analyzed. Furthermore, the novel concept of well barrier hole-burning has been accounted for in the models for the study of additional damping observed in certain quantum well lasers.