ABSTRACT

Optical networks have a significant role to play in the present and future global telecommunication networking scenario due to the increasing demand for larger transmission capacity. Dense Wavelength Division Multiplexing (DWDM) technology provides a cost effective deployment strategy compared to complete overhauling of existing systems to increase capacity. However the linear and non-linear impairments in the fiber channel significantly impact the spectral efficiency of long haul high bit rate DWDM systems. The main focus of this research work is to identify strategies to improve the spectral efficiency of DWDM optical systems in the presence of non-linear effects particularly, Four Wave Mixing (FWM) effect.

The Non-Linear Schrodinger Equation (NLSE) is used to study the propagation behavior of light pulses in optical fibers. In this thesis, the impact of constant and variable step size using non iterative and iterative procedures, in accurately modeling the cross talk components is studied. The Stimulated Raman Scattering effect is also modeled under Full Raman response and Inter band Raman scattering conditions by modifying the NLSE equation using sampling techniques.

The concept of unequal channel allocation for reducing the impact of FWM in DWDM systems is studied; in our work the performances of unequal channel allocation based on Genetic algorithm and Optical Orthogonal Codes is, studied with respect to FWM generation in SSMF,
NZDSF and DSF based DWDM systems. Further to reduce penalties due to the interaction between dispersion and nonlinear effects in the transmission fiber, optimization with respect to modulation format, dispersion compensation ratio and distributed amplification are considered in this thesis.

The performance of DWDM systems with equal and unequal channel spacing is analyzed in terms of Q factor for various modulation formats like RZ-OOK, NRZ-OOK, CSRZ-OOK, VSB-RZ-OOK, DPSK, CSRZ-DQPSK and DQPSK. The best modulation format for long haul high bit rate specification is identified by optimizing the transmit filtering technique among Super Gaussian Higher Order, Arrayed Waveguide Grating and Fiber Bragg Filter by comparing their Q factor performance. The Eye Opening Penalty is also analyzed.

In this work the effect of varying the DCF length for a fixed length of SSMF fiber under pre-, post-, and symmetrical dispersion compensation schemes is analyzed by comparing the Q factor performance for RZ, NRZ and DQPSK modulation formats so as to identify the best dispersion compensation scheme.

A study on the spectral efficiency performance of CSRZ DQPSK under different amplification mechanisms is also undertaken. The ASE noise generated by optical amplifiers decreases the OSNR. Since the distributed Raman amplifiers can reduce the equivalent transmission fiber loss, they are used to improve the Q factor. A 40-Gb/s CSRZ-DQPSK DWDM transmission system using Hybrid Raman/Erbium-doped fiber Amplifier (HREA) is investigated by simulation, considering the non-linear effects and is observed
to yield lowest BER with higher receiver sensitivity and hence a spectral efficiency of 2 bps/Hz with the minimum channel spacing of 20 GHz.

The BER for various modulation formats under dispersion and non-linear impairments is also computed using saddle point approximation method with improved numerical techniques like the secant method and golden section algorithm. BER comparison for RZ-DPSK, NRZ-DPSK and CSRZ-DPSK shows that, CSRZ-DPSK requires a lesser value of $E_0/N_0$ for same BER performance. It can be concluded that a combination of CSRZ DQPSK modulation format, with fiber Bragg narrow bandwidth filtering, pre-dispersion compensation and hybrid Raman amplification is robust to fiber linear and non-linear impairments and can maximize the spectral efficiency and capacity of DWDM transmission systems.