

Table of Contents

Title Page	<i>i</i>
Abstract	<i>ii</i>
Acknowledgments	<i>iv</i>
Table of Contents	<i>v</i>
List of Tables and Illustrations	<i>viii</i>
Chapter 1: Introduction	1
1.1 Optical Fiber Communication Systems	2
1.2 Wavelength Division Multiplexing	4
1.2.1 Why WDM ?	5
1.2.2 State-of-the-Art	8
1.3 Spectrum-Sliced WDM Systems	9
1.3.1 Use of EDFA-ASE as Broadband Source	10
1.3.2 Spectral-Slicing for Local Access Networking	12
1.4 Motivation for this Dissertation	13
1.5 Outline of this Work	
Chapter 2: Signal Detection in Laser-Based Systems	21
2.1 Optoelectronic Receivers	21
2.1.1 Noise Limitations in Optical Receivers	23
2.1.2 Normalized Receiver Sensitivity	24
2.2 Signal Detection	25
2.2.1 Probabilistic Analysis for Digital Lightwave Systems	26
2.2.2 Shot Noise/Quantum Limit to Receiver Sensitivity	29
2.2.3 Thermal Noise Limited Photoreceivers	32
2.3 Erbium-Doped Fiber Amplifiers	35
2.3.1 Gain Dynamics and Noise Figure	37
2.3.2 Amplifier Applications	38
2.4 Photodetection of Optically Amplified Signals	39
2.4.1 Improvement in Receiver Sensitivity	41
2.4.2 Receiver Sensitivity of Optically-Preamplified OOK System	43
2.4.3 Receiver Sensitivity of Optically Preamplified FSK System	45
2.5 Summary	47

Chapter 3: Spectrum-Sliced WDM Using OOK Transmission	56
3.1 Introduction and Motivation	57
3.2 Incoherent Detection of Noise-Like Signals	58
3.3 Receiver Structure and Mathematical Model	60
3.4 PIN Receiver Detection for Spectrum-Sliced WDM	64
3.4.1 Gaussian Approximation	64
3.4.2 Exact Analysis	65
3.5 Optical Pre-amplifier Receiver for Spectrum-Sliced WDM	68
3.5.1 Gaussian Approximation	69
3.5.2 Exact (Chi-Square) Analysis	69
3.6 System Considerations	71
3.6.1 System Transmission Capacity	72
3.6.2 System Power Budget	72
3.7 Use of FEC Coding to Improve Transmission Capacity	73
3.8 Discussion	74
Chapter 4: Spectrum-Sliced WDM Using FSK Transmission	86
4.1 Introduction	86
4.1.1 Why Spectrum-Sliced FSK ?	87
4.2 PIN Receiver Detection for FSK	88
4.2.1 Gaussian Approximation	90
4.2.2 Exact Analysis	91
4.3 Optical Pre-amplifier Receiver for FSK Detection	91
4.3.1 Gaussian Approximation	91
4.3.2 Exact Analysis	93
4.4 FSK vs. OOK	95
4.4.1 Deterministic Laser-Based Systems	95
4.4.2 Spectrum-Sliced Noise-Like Systems	97
4.4.3 Numerical Example	99
4.5 Summary	102
Chapter 5: Effect of Non-Rectangular Spectra on Receiver Sensitivity	113
5.1 Tunable Optical Fiber Filters	114
5.1.1 Use of the Butterworth Filter Approximation	117

5.2 Mathematical Formulation	119
5.2.1 Signal Path in Terms of Filter Parameters	122
5.2.2 Noise Path in Terms of Filter Parameters	124
5.3 OOK Transmission Analysis	125
5.3.1 Gaussian Approximation	125
5.3.2 Chi-Square Analysis	128
5.4 FSK transmission Analysis	131
5.4.1 Gaussian Approximation	131
5.4.2 Chi-Square Analysis	132
5.4 OOK vs. FSK	134
5.5 Summary	135
Chapter 6: Conclusions and Proposal for Future Research	150
6.1 Significance of Investigation	150
6.2 Future Research	153
6.2.1 Effect of Interchannel Distortion and Dispersion	153
6.2.2 Implication of Varying the Line Coding Scheme	153
6.2.3 Noise Reduction Techniques for the Spectrally-Sliced Source	154
6.2.4 Use of Alternate Broadband Sources	155
Appendix A: Use of the Karhunen-Loeve Expansion to Represent EDFA-ASE Noise	156
Appendix B: Error Probability for Spectrum-Sliced FSK Systems	159
References	161
Vita	168