Unit-5

Lecture -5

Coherent Detection, BER, QPSK

Coherent Detection

- Coherent detection provides gain to the incoming optical signal by combining or mixing it with a locally generated continuous-wave (CW) optical field.
- The result of the mixing is that the dominant noise in the receiver is the shot noise coming from the local oscillator.
- Thus the receiver can have a shot noise limited sensitivity.



BER Comparisons

Table	8.4	Summary	of-the pr	oba bil	''ity of erro	r a s	a/uncti	on of	the	nurnber	of
receioed photons p er bitfor coherent opti.calfiber systems											

		Probability	of error	
		Heterod	l}∙rw	
lllfod lation	Homo dyne	Synchronous detection	A n norwonous $detection$	Dtl·ect detection
On-off kleyiog (OOK)	$\frac{1}{2} \operatorname{erfc}(\frac{1}{p'}) \mathcal{D}$	$\frac{1}{2}$ erfc $\left(\frac{1}{2} I \overline{\mathcal{H}}_{p}\right)^{2}$	$-1 \exp(-\frac{1}{2}r, N)$	$\frac{1}{2}\exp\left(-2\eta\overline{N}_{p}\right)$
Pltase-:sbift keying (PSK)	$\frac{1}{2} \operatorname{erfc}(2'17)^n$	$rac{1}{2} \operatorname{erfc} \left(\eta \overline{N}_p \right)^{1/2}$	$\frac{1}{2} \exp(-\frac{m''}{p})$	
Frequeucy-sbift keying (FSK)		$\frac{1}{2} \operatorname{erfc} \left(\frac{1}{2} r, \overline{N}_{p} \right)^{2}$	$1 \exp\left(\frac{1}{2}'^{\prime}N\right)^{p}$	

Comparison of Number of Required Photons per Bit

Table 8.5 Summary of the number of photons required for a 10⁻⁹ BER by an ideal receiver having a photodetector with unify quantum efficiency

	Number of photons					
	271 	Het				
Modulation	Homodyne	Synchronous detection	Asynchronous detection	Direct detection		
On-off keying (OOK)	18	36	40	10		
Phase-shift keying (PSK)	9	18	20	_		
Frequency-shift keying (FSK)		36	40			

Differential Quadrature Phase-Shift Keying

- Multilevel modulation formats are of interest for 10 and 40 Gb/s speeds
- This modulation format transmits more than one bit per symbol.
- In the DQPSK method, information is encoded by means of the four phase shifts $\{0, + \pi/2, -\pi/2, \pi\}$.
- The set of bit pairs {00, 10, 01, 11} is assigned to individual phase shifts.
 - For example, a phase shift of π means that the bit pair 11 was sent.
- Thus DQPSK transmits at a symbol rate of half the aggregate bit rate.
- A DQPSK transmitter typically uses two nested Mach-Zehnder modulators

