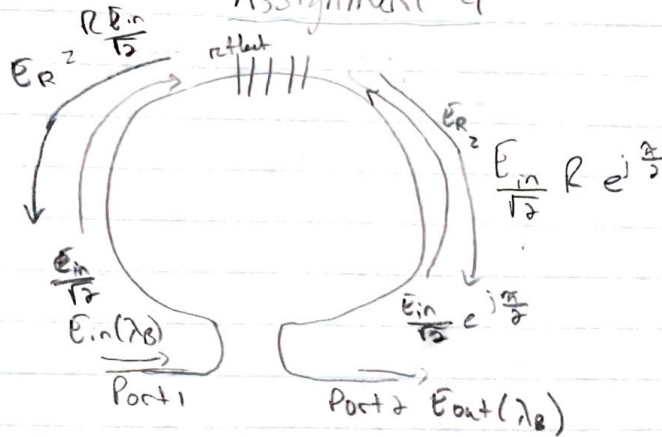


# Assignment 4

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1-



Port 1:

$$E_{out/Port1}(\lambda_B) = \frac{E_{in}}{2} + \frac{E_{in}}{2} e^{j\pi/2} e^{j\pi/2}$$

$$= \frac{E_{in}}{2} + \frac{E_{in}}{2} e^{j\pi}$$

system is out of phase by  $\pi$

$$E_{out/Port1}(\lambda_B) = 0$$

Port 2:

$$E_{out/Port2}(\lambda_B) = \frac{E_{in}}{2} e^{j\pi/2} + \frac{E_{in}}{2} e^{j\pi/2} = E_{in} e^{j\pi/2}$$

system is in phase.

$$E_{out/Port2}(\lambda_B) = E_{in} e^{j\pi/2}$$

2-a)  $n_{eff} = 1.45$   $\lambda_B = 1550 \text{ nm}$

$\lambda_B = 2n_{eff} \Lambda$

$\Rightarrow \Lambda = \frac{\lambda_B}{2n_{eff}} = \frac{1550 \times 10^{-9} \text{ m}}{2(1.45)} = \boxed{0.534 \mu\text{m}}$

b)  $P_{in} = 1 \text{ mW}$   $R = 99\%$  reflecting

i)  $P_{\text{through load}} = ?$   $P_{\text{through input}} = ?$

We know  $R = 99\%$  so  $1\%$  transmits through

$P_{\text{through input}} = 1 \text{ mW} (0.01) = 0.01 \text{ mW}$

We know  $R = 99\%$

$P_{\text{through load}} = (2 \text{ mW})(0.99) = 1.98 \text{ mW}$

cross talk  $= \frac{0.01 \text{ mW}}{1.98 \text{ mW}} = 0.00505$

$\boxed{\text{cross talk} = -22.967 \text{ dB}}$

ii)  $P_{\text{drop input}} = (1 \text{ mW})(0.99) = 0.99 \text{ mW}$

$P_{\text{drop load}} = (2 \text{ mW})(0.01) = 0.02 \text{ mW}$

cross talk  $= \frac{P_{\text{drop load}}}{P_{\text{drop input}}} = \frac{0.02 \text{ mW}}{0.99 \text{ mW}} = 0.0202$

$\boxed{\text{cross talk} = -16.95 \text{ dB}}$

c) i)  $P_{\text{through input}} = 1 \text{ mW} (0.01) (0.01) = 10^{-4} \text{ mW}$   $P_{\text{through load}} = 1.98 \text{ mW}$

cross talk  $= \frac{P_{\text{through in}}}{P_{\text{through load}}} = \frac{10^{-4} \text{ mW}}{1.98 \text{ mW}} = 5.05 \times 10^{-5}$

$\boxed{\text{cross talk} = -42.967 \text{ dB}}$

- ii) Since there is the addition of the terminated ends there will not be any power that will appear on the other side. As the signal is sent to the terminated end in the middle section the  $P_{drop/add} = 0$

$$\boxed{\text{Crosstalk} = 0}$$

$$3-a) Q = \frac{V_1 - V_0}{\sigma_1} = \frac{V_0 - V_0}{\sigma_0}$$

$$V_0 = \frac{\sigma_0 V_1 + \sigma_1 V_0}{\sigma_0 + \sigma_1}$$

$$Q = \frac{\sigma_0 V_1 + \sigma_1 V_0}{\sigma_0 + \sigma_1} - \frac{V_0 (\sigma_0 + \sigma_1)}{\sigma_0 + \sigma_1}$$

$$= \frac{\sigma_0 V_1 + \cancel{\sigma_1 V_0} - V_0 \sigma_0 - \cancel{\sigma_1 V_0}}{(\sigma_0 + \sigma_1) \sigma_0}$$

$$= \frac{\sigma_0 V_1 - V_0 \sigma_0}{(\sigma_0 + \sigma_1) \sigma_0} = \frac{V_1 - V_0}{\sigma_0 + \sigma_1}$$

$$Q = \frac{1.5V - 0.3V}{0.04 + 0.06} = 12$$

$$\boxed{Q = 12}$$

b) Gaussian Statistics.

$$BER = p(1)P(0|1) + p(0)P(1|0)$$

$$= \frac{\exp(-\frac{Q^2}{2})}{Q \sqrt{2\pi}}$$

$$BER = \frac{e^{-\frac{12^2}{2}}}{12\sqrt{2\pi}} = 1.7886 \times 10^{-33}$$

$$c) \text{ BER} = \frac{1}{2\sqrt{\pi \text{SNR}}} e^{-\text{SNR}}$$

$$2\sqrt{\pi \text{SNR}} \text{ BER} = e^{-\text{SNR}}$$

$$\ln(2\sqrt{\pi \text{SNR}} \text{ BER}) = -\text{SNR}$$

$$\ln(2) + \frac{1}{2}\ln(\pi \text{SNR}) + \ln(\text{BER}) = -\text{SNR}$$

$$\frac{1}{2}\ln(\pi \text{SNR}) + \text{SNR} = -\ln(2) - \ln(\text{BER})$$

Work by trial and error to solve SNR

$$\boxed{\text{SNR} = 24.8}$$

d) 1) Increase fiber insulation to shield from external noise

2) Increase the signal power to increase S of the signal

4-a) ~~Refer~~ Refer to Matlab code.

1- In order for error free transmission  $\text{BER} \approx 10^{-12}$

$$\text{BER} = 10^{-12}$$

$$\text{BER}_{\text{dB}} = -120 \text{ dB}$$

for  $\text{BER}_{\text{dB}} = -120 \text{ dB}$ , the  $\text{OSNR}_{\text{dB}} \approx 19.8 \text{ dB}$

$$\boxed{\text{OSNR}_{\text{dB}} = 19.8 \text{ dB}}$$

$$b) \text{ OSNR} = 16.01 \text{ dB}$$

$$\text{BER} = 4.0457 \times 10^{-4}$$