NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3550 FINAL EXAM 12/92 Po

- This exam is open book and notes.
- There are five problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be sure to include units in your answers.
- Please circle or underline your answers.
- Show *ALL* work.
- Write only your name on this sheet.
- Have a good holiday season and enjoy your break!

Course grade: _____

1		4	
2		5	
3			
Total			

Name: _____

IMPORTANT: Questions 1–4 concern the data link shown on the next page.

1. If the data rate of "Signal In #1" is 55 Mb/s, calculate the length of the link when limited by the losses for this signal.

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2. If the data rate of "Signal In #1" is 55 Mb/s, calculate the dispersion–limited length of the link for this signal.

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3. If link length is 50 km, find the maximum allowable data rate of "Signal In #2" as determined by the losses.

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4. If link length is 50 km, find the maximum allowable data rate of "Signal In #2" as determined by the fiber dispersion.

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5. A chain of 50 cascaded amplifiers has been proposed to work in a fiber optic link. The amplifiers have the properties listed below and are spaced 50 km apart. The fiber between the amplifiers has a loss of 0.6 dB/km. The amplifier cascade has been designed to ensure that the signal power out of each amplifier is equal to the signal power of the transmitter (3 dBm) at 1530 nm. The electrical bandwidth of the receiver is 2 GHz.

Amplifier Specs

Parameter	Value
G_0	32 dB
LG_0	2.4
B of optical filter	10 nm
B of optical amplifier	25 nm
n_{sp}	1.5

   (a) Find the ASE noise power at the output of the 50–th amplifier.

   (b) A receiver is placed after the 50–th amplifier. Assuming that the ASE–related noise is dominant, calculate the minimum BER that can be supported by this link.

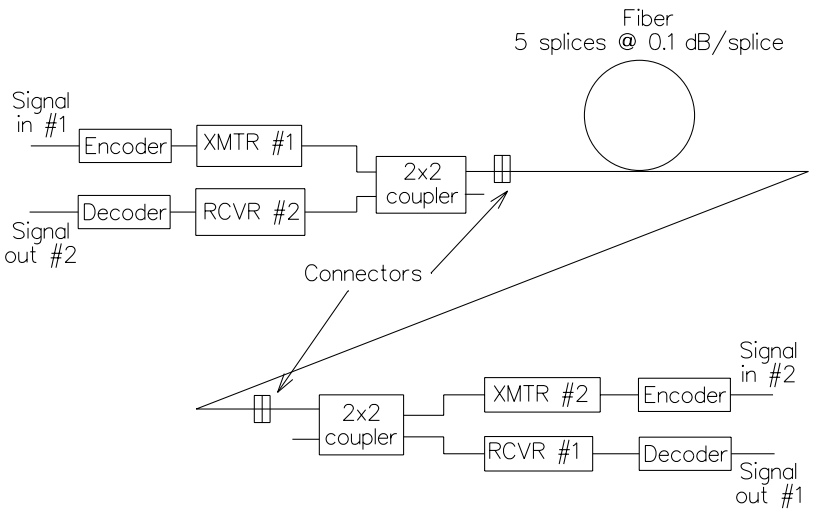

Figure 1: System for Problems 1–4.

Source Specs

Parameter	XMTR #1	XMTR #2
λ	1300 nm	1550 nm
Power	1 mW	1 mW
$\Delta\lambda$	8 nm	2 nm

Fiber Specs

Parameter	Value
Dimensions	9/125 μm
Type	Single-mode
Losses	0.45 dB/km at 1300 nm
	0.35 dB/km at 1550 nm
Dispersion (total)	0.25 ps$\cdot$km$^{-1}\cdot$nm^{-1} at 1300 nm
	1.5 ps$\cdot$km$^{-1}\cdot$nm^{-1} at 1550 nm
Aging allowance	0.03 dB/km

Coupler Specs

Parameter	Coupler value
Splitting loss	6 dB
Insertion loss (each channel)	1 dB

Receiver sensitivity (power required for BER of 10^{-9}): $P_R = 11.5\log(\text{DR}) - 60.5$ dBm where P_R is *in dBm* and DR is the data rate *in Mb/s*.

Coding: RZ, Manchester encoding

Connector losses: 3 dB (per pair)