3.46 PHOTONIC MATERIALS AND DEVICES

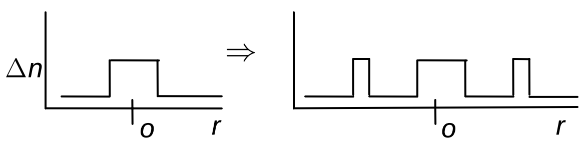
Lecture 3: System Design: Time and Wavelength Division Multiplexing

Lecture

<u>DWDM Components</u>

<u>Fiber</u> (α = 0.2 dB/km)
core: d = 8 μm
clad: d = 125 μm
Δn = 0.5%

Dispersion control: D↓



<u>Amplifier (EDFA)</u>

SiO_2 : Er (100 ppm)

Al_2O_3 doping → Al^{3+} ⇒ more Er^{3+} w/o clustering

L = 20-60 meters
Amplification = 10^3-10^4

BW: 12 nm → 16 ch
35 nm → 80 ch
80 nm → 200 ch

Waveguide amplifier Δ = 10%

Higher Δ than fiber : higher pump rate

<u>Dispersion compensation</u>

Broader spectrum → D fiber (opposite dispersion filter)

CATV → 1 amp/1000 homes

More BW

+Sb-doping → more BW
+Yb → pumping efficiency

<u>System</u>

40 Gb/s ⇒ D_{max} = 63 ps/nm

10 Gb/s ⇒ D_{max} = 10^3 ps/nm

Lecture

$B^2 \uparrow DL \approx 10^5$ ps/nm • (Gb/s)^2

1 dB system penalty

$\Rightarrow$ B $\uparrow$ by 2$\times$, D $\downarrow$ by 4$\times$

Filters (MUX, deMUX, add/drop)
Mach. Zehnder interferometer
T (delay) = L n_g/C_0

n_g = group index

$$H(\nu) = \frac{1}{2}\left[1 - e^{-j2\pi\nu T}\right]$$

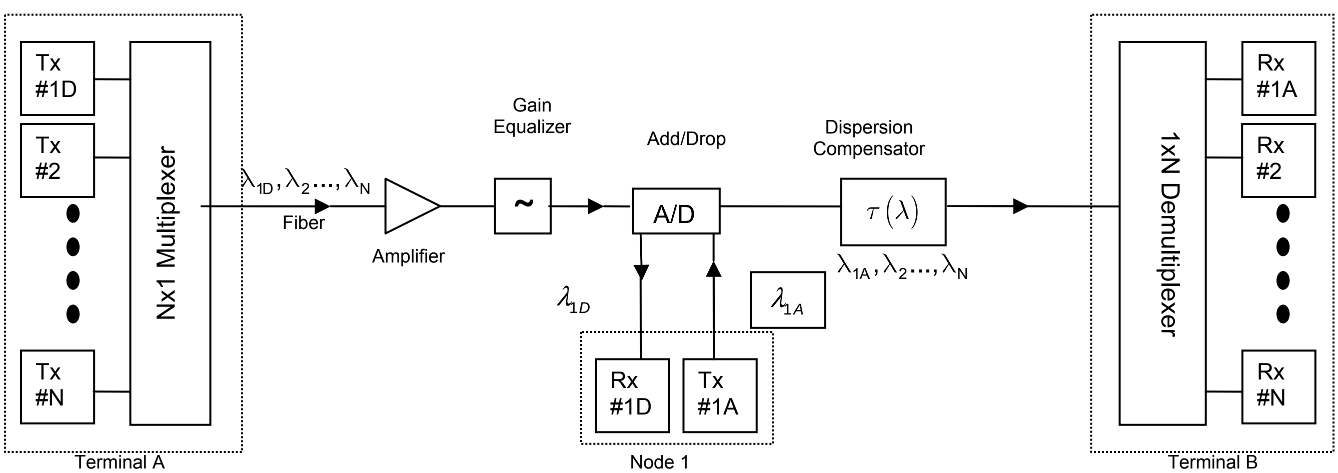
<u>Fabry-Perot interferometer</u>

$$H(\nu) = C_n e^{-j(2\pi\nu n - \Phi_n)}$$

$$\text{FSR} = \frac{1}{T} = \frac{C_0}{nL}$$

FSR = free spectral range

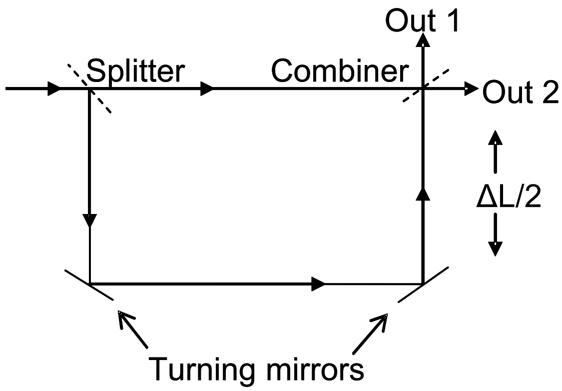
T = 100 ps $\Rightarrow$ FSR = 10 GHz



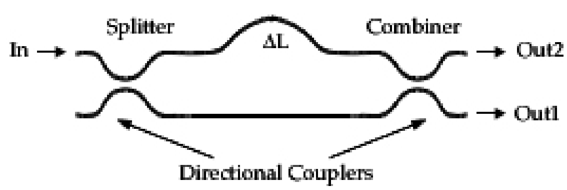
Filter applications in a simplified WDM system

Lecture

Notes



(a)



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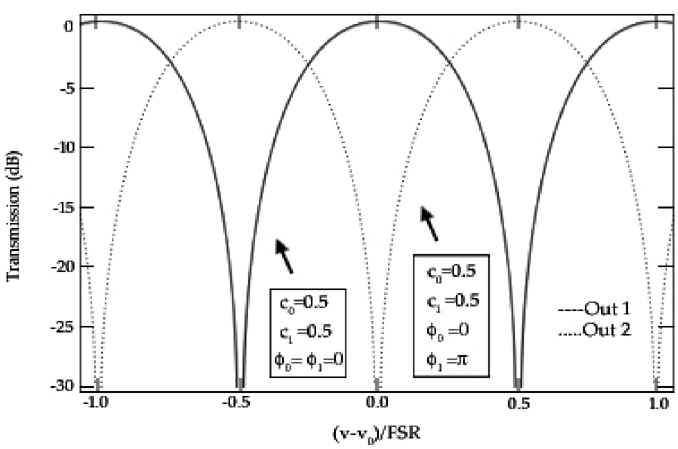
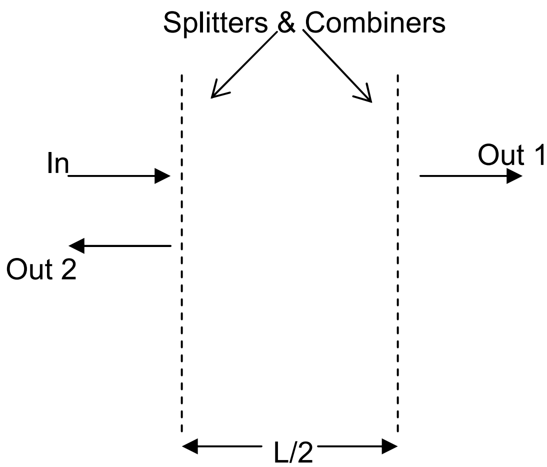
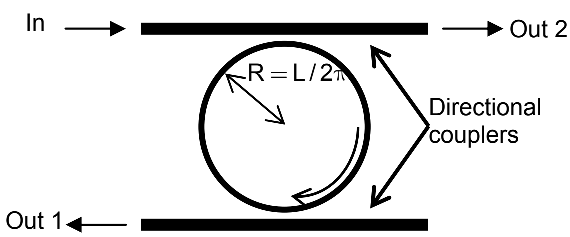


(c)

A Mach-Zehnder interferometer: (a) free-space propagation, (b) waveguide device, (c) transmission response.



(a)



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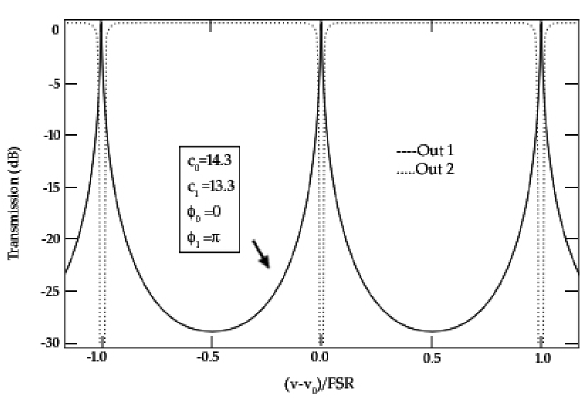

(c)

A Fabry-Perot interferometer: (a) free-space propagation, (b) waveguide analog, and (c) transmission response.