

Question 2

Dispersion is a technique wherein components of a signal travel at different velocities and reach the receiver at different intervals.

The various forms of dispersion in optical communication system are

Chromatic Dispersion

Polarization mode Dispersion

Intermodal Dispersion

In Chromatic Dispersion - the various signal frequencies travel at different velocities and reach the receiver at different time intervals

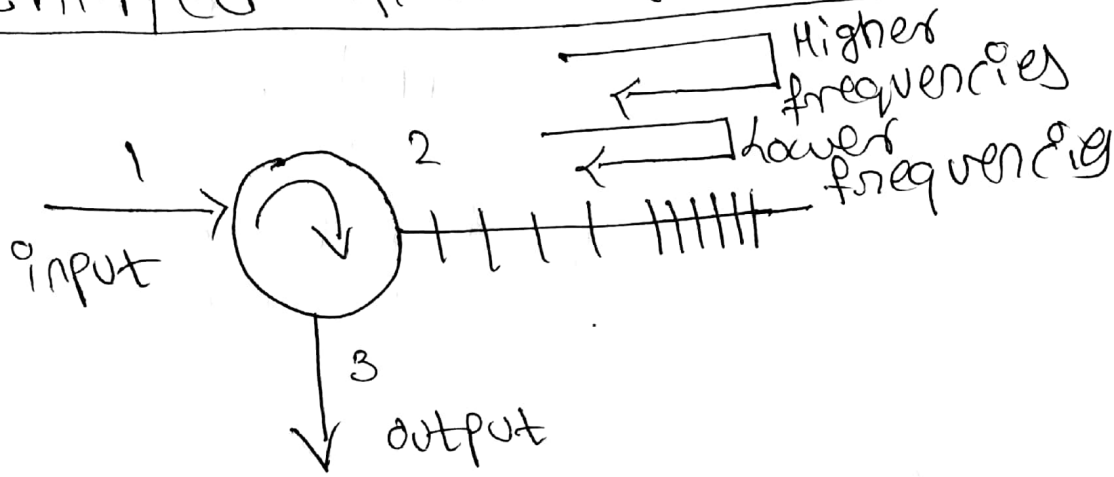
Polarization mode dispersion - This occurs when the core of optical fiber is not circular and hence the signal components reach at different velocities

Intermodal Dispersion - This dispersion occurs only in multimode fibers and components of each mode travel at different velocities.



This dispersion is not applicable for single mode fibers.

Chirped fiber gratings

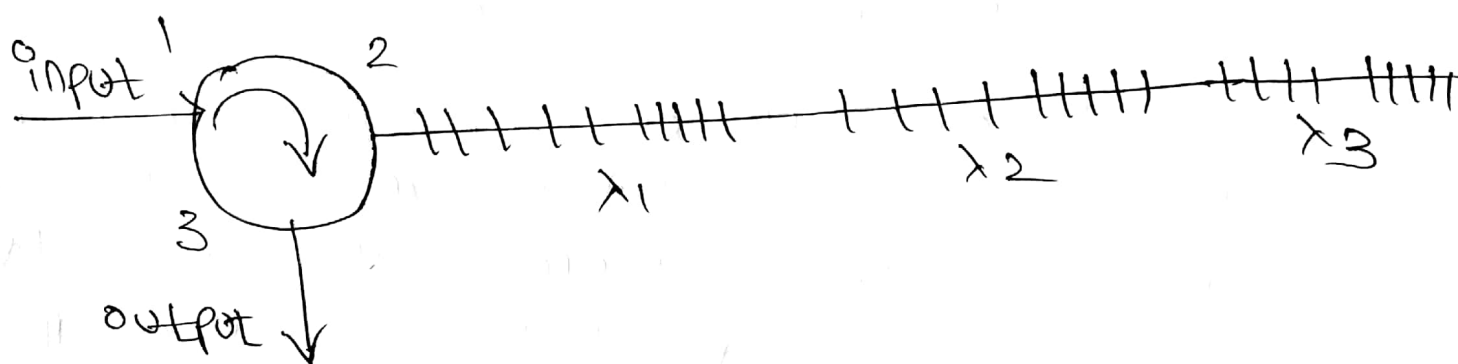
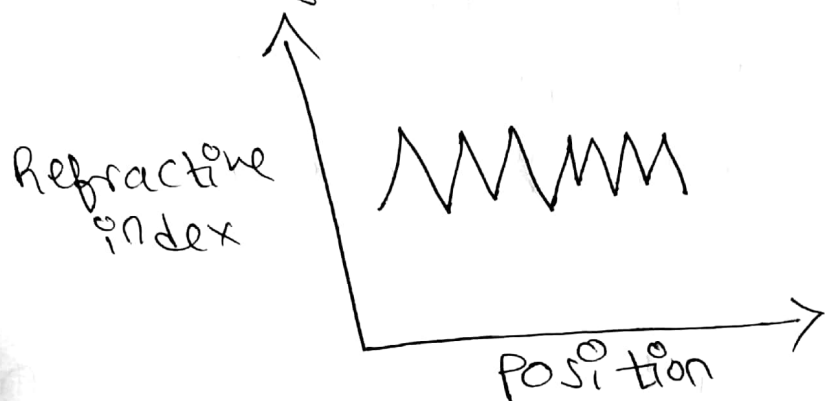


In order to compensate for chromatic mode dispersion, chirped fiber grating is introduced.

In conventional chromatic dispersion larger delays occur for low frequency signals however we would reverse this operation and make it for higher frequency delays for high frequency signals.



→ The gratings are linearly polarised and vary with position.



→ chirped fiber grating is more advantageous for a single wavelength than multiple wavelengths.

However, DFA is better than chirped fiber grating because it would operate for multiple wavelengths but creates more distortion and other side effects.

Question 3

wavelength converters - These are devices that are used to convert data from one input wavelength to other output wavelength.

wavelength conversion is needed in WDM for the following 3 reasons -

It can act as a Transponder when for example - 1st generation networks operate with 1310nm and use LED's or Fabry Perot Lasers. However both wavelength and lasers are not compatible for a WDM system. So, a wavelength converter can be used to convert to a desired wavelength.

wavelength converters can be used with the system to help provide efficient utilization of the wavelength.

Some wavelength converters are used when the networks are controlled by entities which do not have a proper wavelength specification, hence they are used in network boundaries.

Wavelength converters are divided based on their inputs and outputs namely:

⇒ Fixed input fixed output - Here the fixed input wavelength is considered and fixed output wavelength is produced.

Fixed input variable output - fixed input wavelength is let in and a variable output is produced.

Variable input variable output - Both the input and output wavelengths are variable.

⇒ Variable input fixed output - Input wavelength is ~~fixed~~ varied and output wavelength is fixed.

The ways to achieve wavelength conversion are

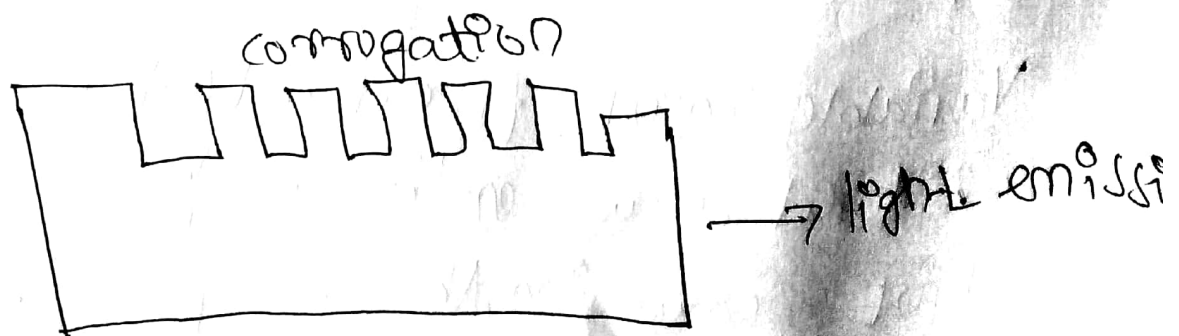
- * Optical electronic
- * Optical gating
- * Interferometric
- * Wave Mixing.

Optical electronic is commercially used in many applications whereas the other 3 are not yet comparable for commercial usage.

Question 4

① DFB - Distributed Feedback Switch

Whenever a laser uses a corrugate membrane in order to produce a single longitudinal mode then that switch is termed as DFB switch.

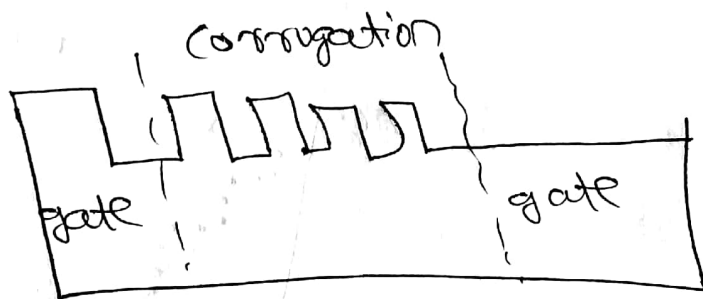


* when the incident signals are being reflected after corrugation, these signals can be added together when the period of corrugation is an integral multiple of half of wavelength of spacing.

* This phenomenon is termed as Bragg Condition.

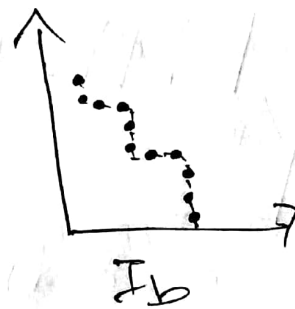
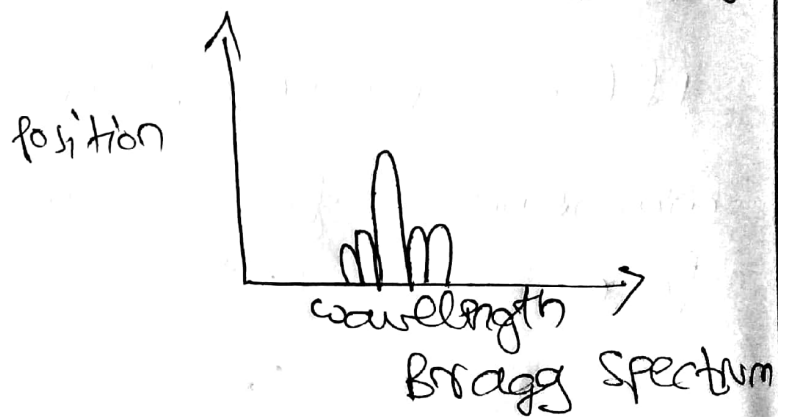
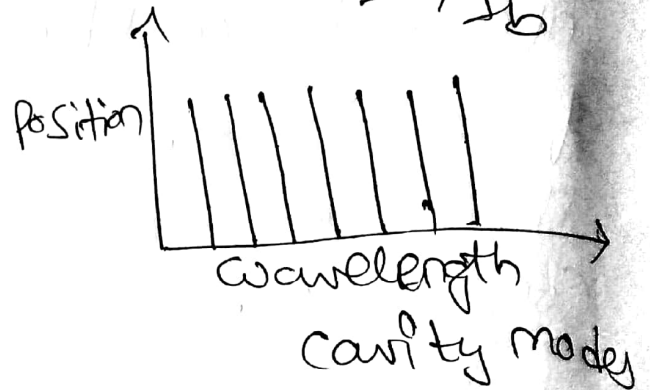
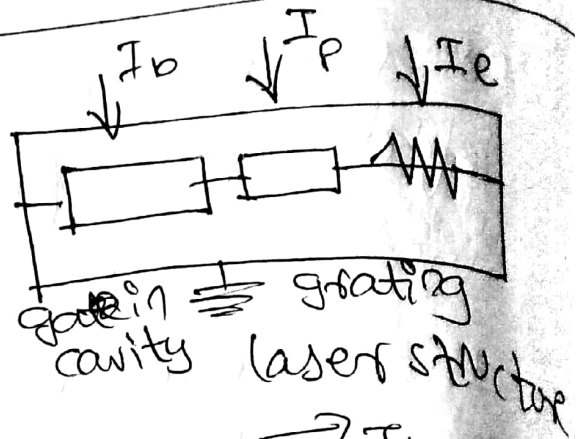
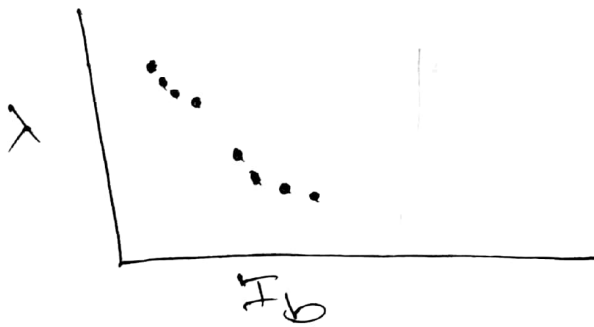
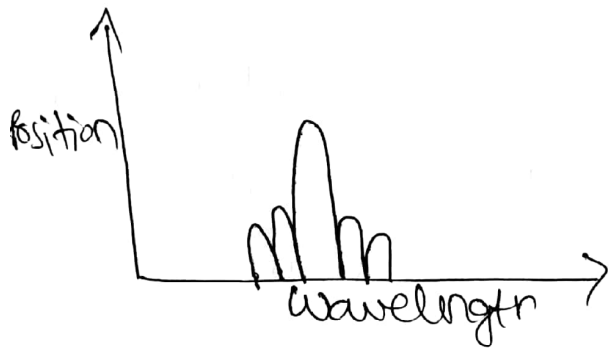
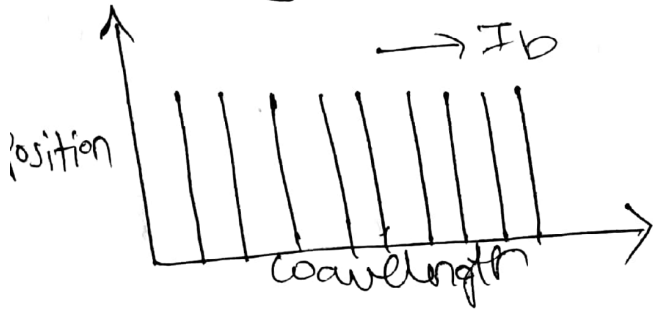
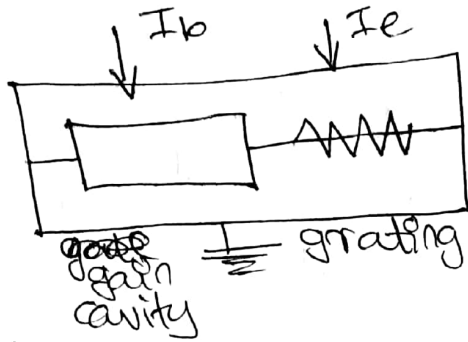
DBR - Distributed Bragg Reflectors

whenever the corrugation is decoupled from the gate it is called as DFB



* This is more advantageous as the corrugations can occur independently within the device

DFB switches are difficult to construct than FP lasers and hence not much in commercial usage.



In a conventional PBR laser it consists of only one gain cavity and it is being controlled by inducing a forward bias current I_b and this could control the output current.

however, it is independent of wavelength.
 we can induce an electrode with a current I_e which would control the wavelength and is independent of other components.

The cavity modes represent the cavity length and with every increase in current I_b , the wavelength hops from one cavity mode to another.

The highest peak in the cavity mode which could be equal to the peak of the Bragg spectrum is considered.

In order to tune to entire wavelength another current I_p (Phase current) is used which helps in tuning for entire wavelength.

The Fig. shows tuning only for a small portion of the entire wavelength.

DFB and DBA lasers mainly operate for 32 channels at 30 GHz

- * The tuning range is between 10-15 dB and refractive index is 0.5-2%.
- In order to increase more than tuning range we need to apply 2 tricks
- Vernier effect - 2 combs of wavelengths are used which are having a wavelength spacing.
 - The laser wavelength must be greater than the difference between any 2 ~~refractive~~ wavelengths.

Question 5

Cross talk mainly occurs when one signal overlaps with another signal.

In WDM system cross talks are of 2 types

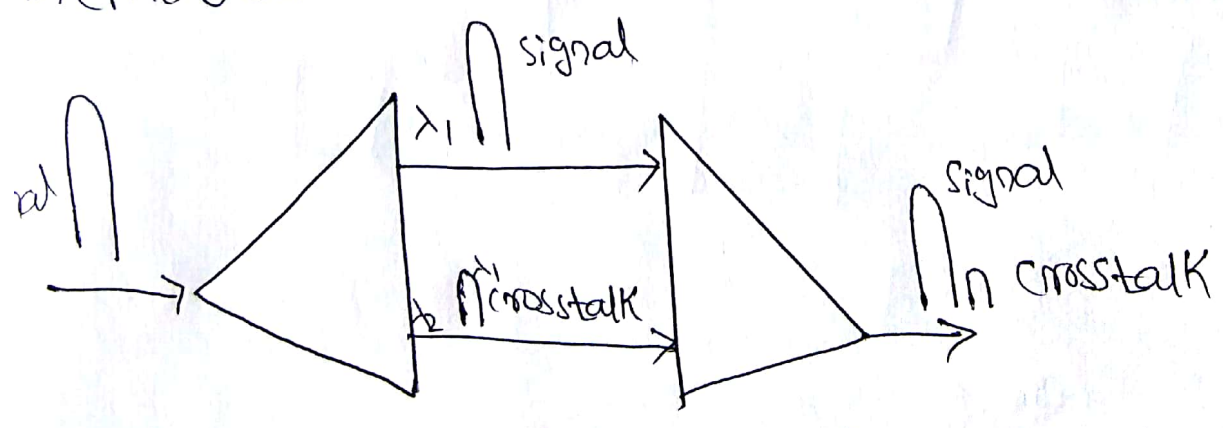
- Interchannel crosstalk
- Intrachannel crosstalk

Interchannel crosstalk arises when the crosstalk signals and the original signals wavelength is different and the difference between these 2 signals is greater than the receivers electrical bandwidth.

Intrachannel crosstalk arises when the crosstalk and the original signal have same wavelength and are within the receivers electrical bandwidth.

Intrachannel Crosstalk

It is mainly caused because of variation in wavelength, however this can be removed and hence is not severe.

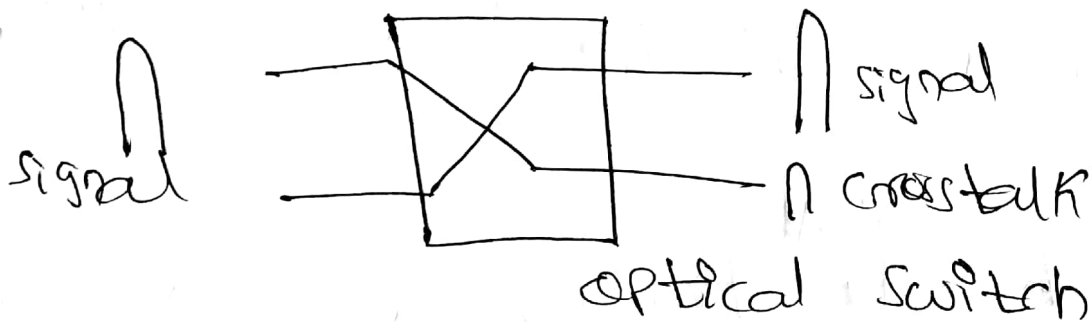


The crosstalk occurs because of the coupling variations between the multiplexers.

and demultiplexers.

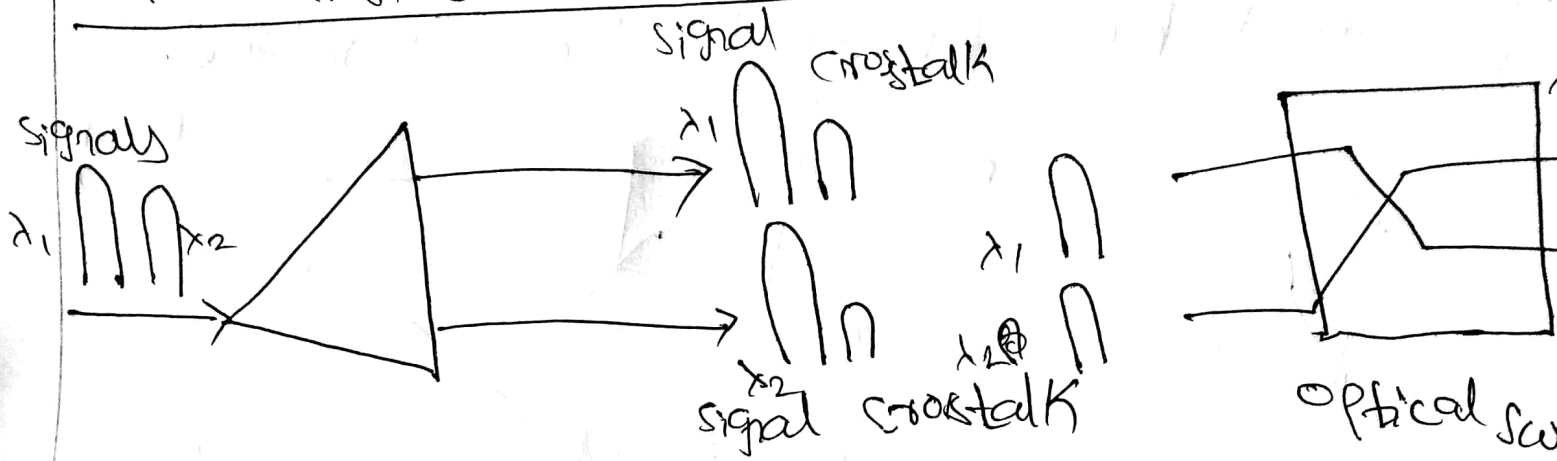
The signal suppose λ_i could leak into λ_{i+1} because of suppression it could cause the same crosstalk at the output.

Although the same data is carried between both wavelengths the signals are out of phase, hence ~~interference~~ crosstalk occurs.



Crosstalk occurs in a 2D switch because of isolation.

Interschannel Crosstalk



- * This crosstalk occurs within the receivers electrical bandwidth.
- * At the input side it could select only one signal and reject others and crosstalk is observed.

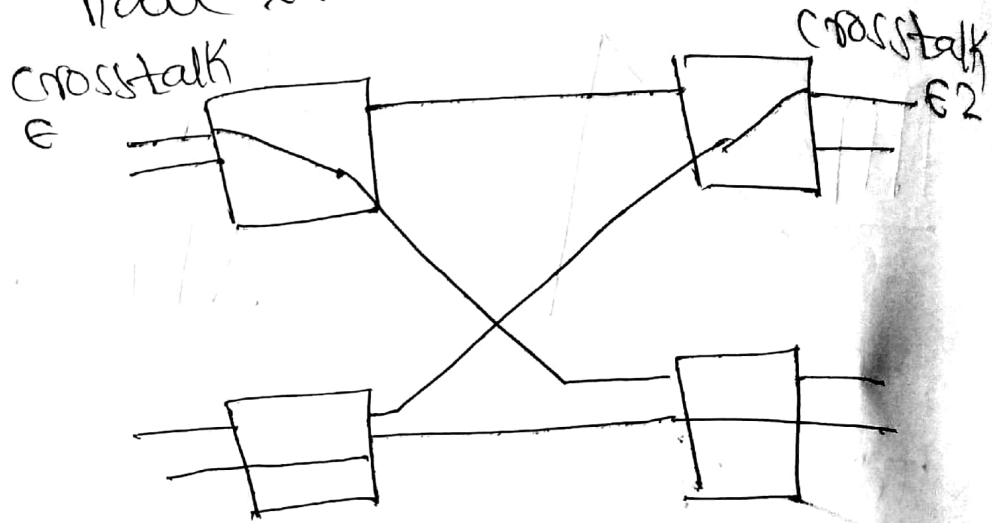
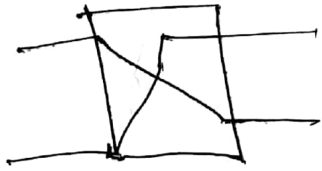
Switch crosstalk can be reduced in 2 ways

Switch dilation
wavelength method.

In switch dilation - The dilation of switch takes place

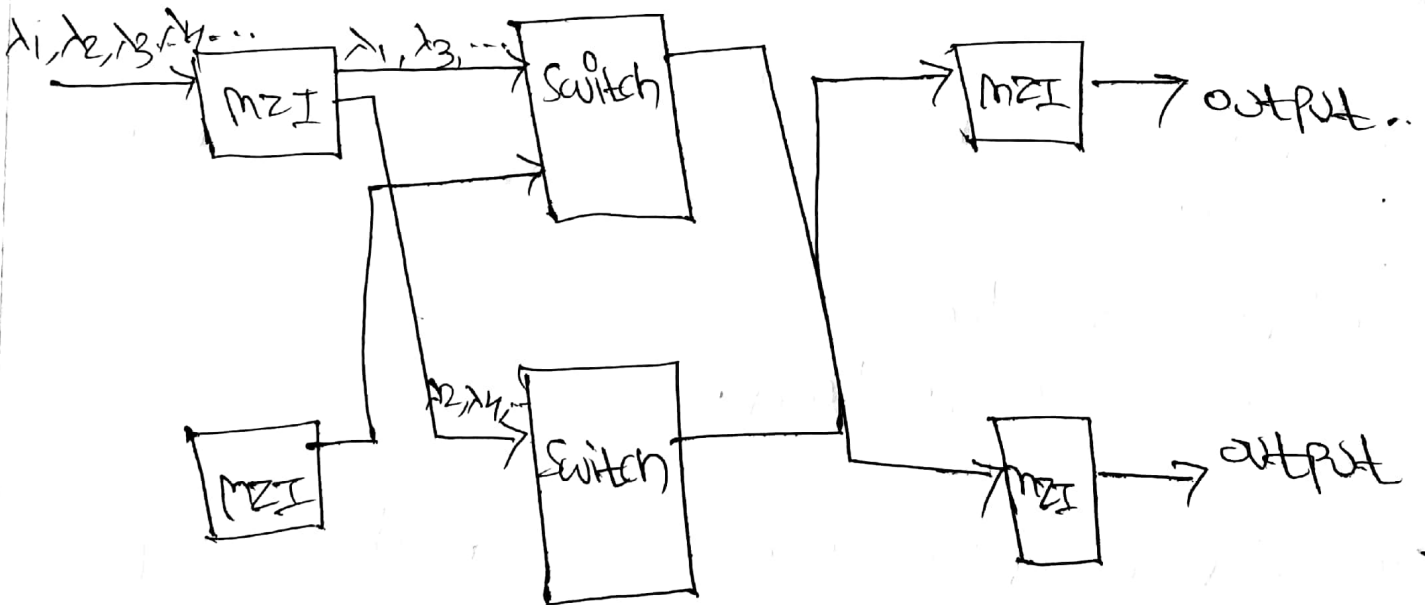
- Additional unused ports are being added to prevent crosstalk.

one disadvantage is that more number of switches have to be involved.



→ At input crosstalk is ϵ and at output crosstalk observed is ϵ^2 .

wavelength technique



→ In this method, a range of wavelengths are inputted

- The wavelengths are being split on basis of odd and even and sent to the switches.
- However in this method only a single switch is used unlike in the dilation technique.
- The outputs of switches are again passed on to the MZI and necessary output is produced.

Question 1

1. The switch must produce high output power. In a WDM system the output power ranges from 0 - 10 dBm. The other parameters that involve are the threshold current and slope efficiency.

Threshold current is the input power being induced to a switch

Slope efficiency is ratio of input power to the induced current.

The switch must have narrow spectral width. Hence it can travel through multiple channels and interchannels.

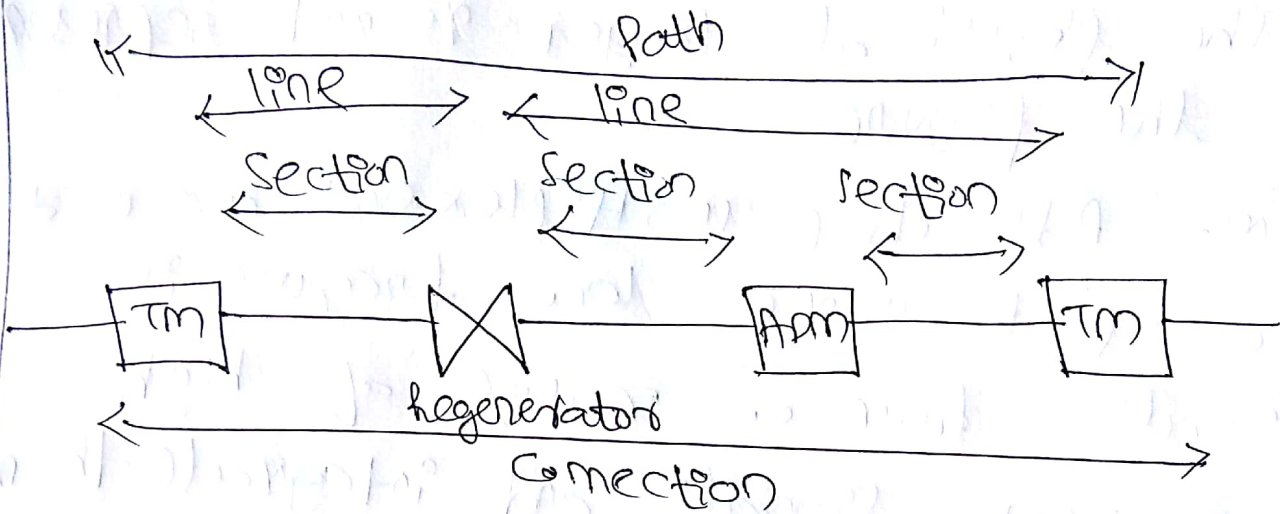
The switch must have wavelength stability. At constant temperatures, the wavelength drift must be less than the life of the laser oscillation.

Switch must be applicable for wider usage under optimistic conditions. It must be able to transmit a suitable set or a single wavelength and help in transmission.

Some of the optical transmitters include LED's, lasers, etc.

Questions

Four sublayers of SONET/SDH



The four layers are path, line, section and physical layer

The path, line and section have overhead bytes which would be added to the network during transmission and removed from network after transmission

→ The path is end to end connection of a SONET/SDH

→ The last element of path is always a Terminal multiplexer (TM)

→ Line is used to multiplex paths