: Programmable silicon photonics circuit :

- To program the silicon photonic IC chips so that light inside the chip can be changed.

Q: why it is needed?

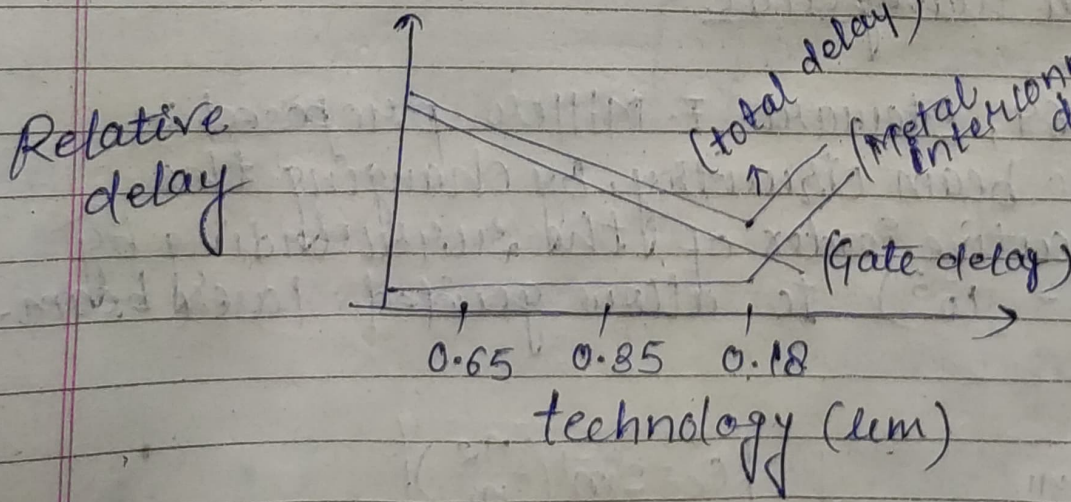
Ans: As light always propogates in straight lines hence to change its dirn we have to use lenses which is difficult in IC.

→ hence by programming, we can change light direction.

: Evolution of silicon photonics :

→ 1965 - Moore's law

'Number of transistors per square inch on an IC doubled every 24 months which was revised to 18 months.



- As no. of transistors increase, the metal interconnect area reduced ($R = \rho \frac{l}{A\downarrow}$), resistance increases.

Laser diode - 1962 by Robert N. hall.

also the density of metal interconnect increases (C↑)

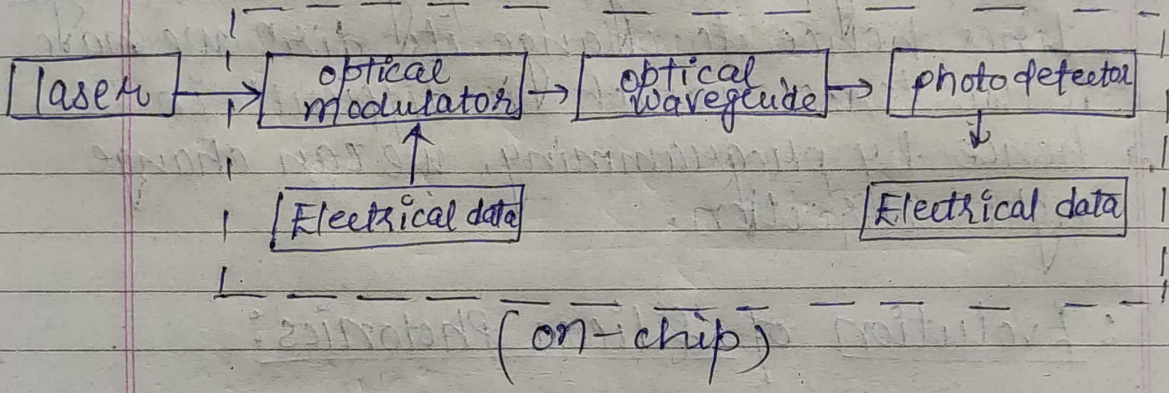
hence RC = time constant ↑

speed ↓.

(Electrical interconnect bottleneck)

To overcome this problem:

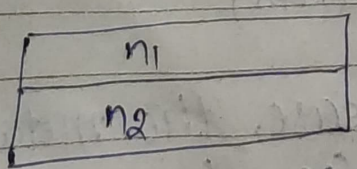
optical Interconnect



→ we can convert Electrical signal to optical signal and avoid the metal interconnect

optical waveguide:

In 1969, Stewart E. Miller proposed:-
Laser beam circuitry, by changing the refractive index of the surrounding by (10^{-2} - 10^{-3}) to allow guided laser beam.



$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$

⇒ total internal reflection.

Optical Modulator :

"Ivan P Kaminow"

Lithium niobate Ridge waveguide modulator

↓

by changing applied voltage, refractive index of material changes, hence phase velocity of the optical wave changes.

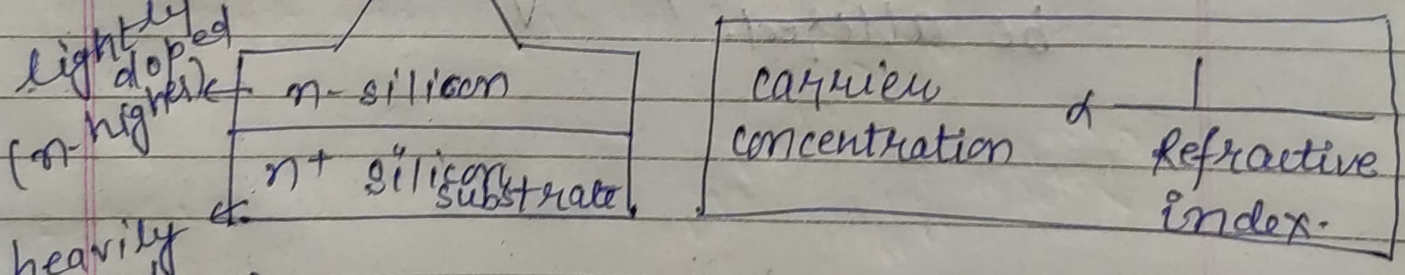
: Photonics on Silicon chip :

"Richard Soref" - Father of Silicon photonics.

↳ He gave the concept of Silicon Superchip.

→ means to fabricate all the photonic element by using 'Silicon'.

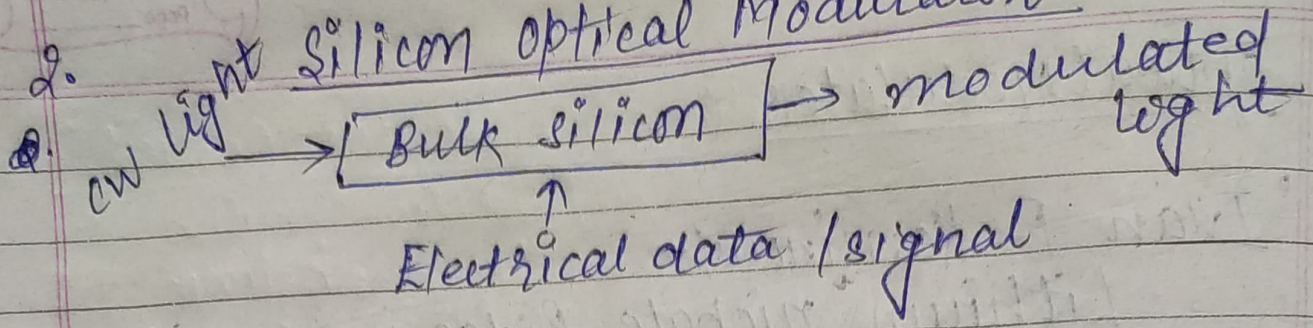
1. On-chip optical waveguide -



→ By injecting the current, carrier concentration change, and hence refractive index changes.

Q. → hence we can achieve higher refractive index and lower refractive index region for guided wave.

2. Silicon optical Modulator



3. Photodiode:

SiGe $\left[\begin{array}{l} Eg_{Si} = 1.21\,eV \\ Eg_{Ge} = 0.7\,eV \end{array}\right]$

By forming alloy of SiGe and by bandgap engineering we can get:

$$0.7 \leq Eg < 1.21\,eV$$

Objective:

→ By doing machine learning program inside the chip, light (dir) would be altered.