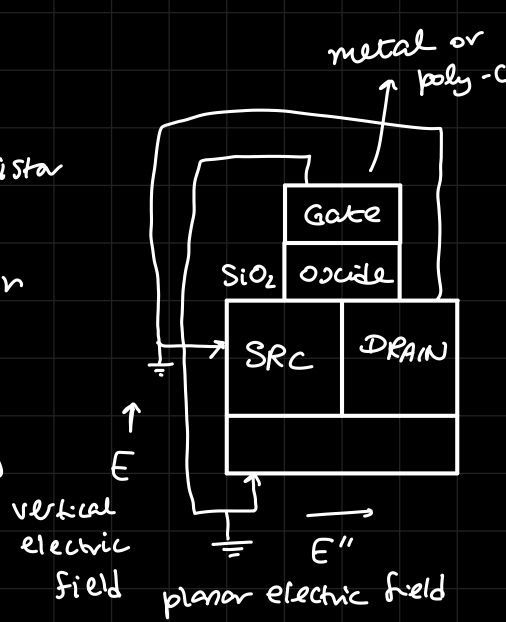
• LECTURE: 2

point contact transistor
- had germanium instead of silicon
- walter Brattain
- John Bardeen
- william shockley
- Bell labs
- 1947



also called planar MOSFET

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* Moore's Law : 1974

num of transistors on ICs doubles approx (~1.8x) every two years to improve the chip performance
- also cost effective
- Keeping the overall area same, we double the number of transistors

Log-linear relationship between device complexity (higher ckt density at reduced cost)

our regular computers deal with bits whereas quantum computers are based on q-bits

* Semiconductor wafer
- thin slice of semiconductor used for fabrication of ICs, solar cells etc.
- Semiconductor: crystalline silicon/ germanium...
  - regular arrangement of atoms
  - not amorphous
    - irregularities present
  - covalent bonding → not ionic bonding where e^- are tightly packed
    - e^- are loosely bound in the outermost shell

SiO_2. glass/sand
- Silicon dioxide

Poly-Crystalline also used for gate
- In between amorphous and crystalline

Transistors have PN Junction
- has flow of holes and electrons

* CAPACITOR: two copper plates which have dieletric between them where electric field flows

if $\bar{E}$ is very high → MV/cm
if $\bar{E}$ exceeds further than a set threshold
dielectric bedrum
- no longer acts as a capacitor

* CLASSICAL VS QUANTUM MECHANICS

describe behavior of macroscopic objects → observable by eyes	describe behaviour of systems of atomic level	behaviour of physical objects when subjected to forces/displacement

speed/position: $\underbrace{\text{dynamic}}_{}$ variable/parameters of a system of a certain mass
changes with time

define parameters without approximation
Deterministic behaviour works in classical mechanics
Probabilistic/statistical behaviour works in quantum mechanics
for atomic level, we use instruments to measure parameters and hence there will be some limit to precision

* Wave Particle DUALITY

wave-like particle behaviour
eg: photoelectric effect

particle-like wave behaviour
eg: Davisson-Germer experiment

State function of...
- classical mech : $f(x,t)$
- quantum mech : $\Psi(x,t)$ can be represented as $Ae^{i\phi}$

$p = mv$
momentum of a photon: $p = \frac{h}{\lambda}$ (h → planck constant)

wavelength of a particle : $\lambda = \frac{h}{p}$
de Broglie wavelength

when can an object that appears as particle behave as wave?
- when the dimension(r) over which the change of potential energy $V(r)$ of a particle becomes smaller as compared to its wavelength, its wave nature reveals.

eg: $\lambda_{baseball} \approx 10^{-34}\,m$
- → very small wavelength
- → cannot be visualized
- → doesn't behave as wave

$\lambda_{electron} \approx 10^{-10}\,m$
- → ~Å atomic level
- → can be visualized
- → behaves as wave

* HEISENBERG'S UNCERTAINITY PRINCIPLE 1927

conjugate variable : possible to move from one domain to another using Fourier Transform

$$\Delta p \Delta x \geq \hbar$$
$$\Delta E \Delta t \geq \hbar$$

if we want to precisely measure one var, the other in the conjugate pair cannot be precisely measured

Energy of a quantum system cannot be zero because of the uncertainity principle

The lowest Energy we can attain is Zero-Point Energy

$E = KE + PE$
if $PE = 0$,
KE cannot be zero due to the uncertainity principle
KE should be atleast $\left(\frac{\hbar}{\Delta x}\right)^2$

$KE = \frac{p^2}{2m}$

A continuous distibution of wavelengths can produce a localized wave packet.

- Quasi-Particle
  - In photoelectric effect
  - not an actual particle

Si → $14e^-$
$4e^-$: valence shell

• WAVE FUNCTION $\{\Psi : Psi\}$

Describes the quantum state of an isolated system of one or more particles. There exists only one wave function containing all info for an entire system.