

Section 24

Bipolar Junction Transistor - Fundamentals

Gerhard Klimeck

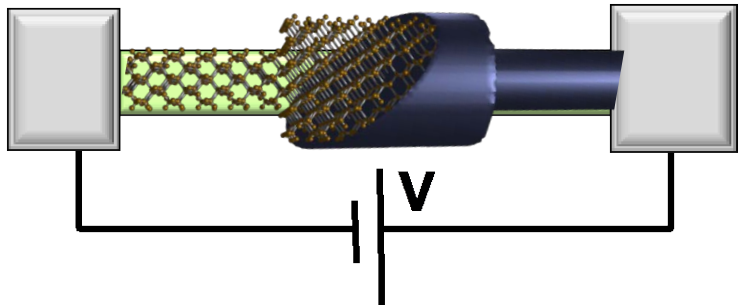
gekco@purdue.edu



School of Electrical and
Computer Engineering

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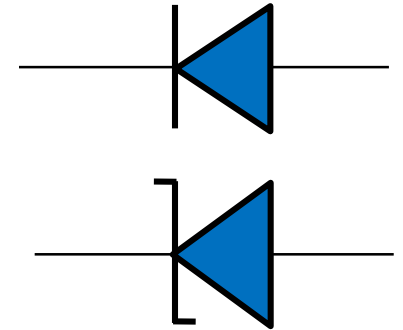
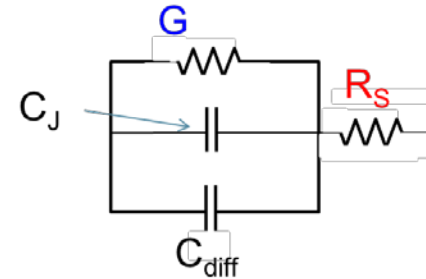
Bipolar Junction Transistor - Fundamentals



$$I = G \times V$$

$$= q \times n \times v \times A$$

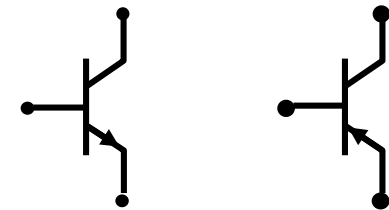
↑ charge density ↑ velocity area



	Equilibrium	DC	Small signal	Large Signal	Circuits
PN Diode	◊	◊	◊	◊	
Schottky Diode	◊	◊	◊		
BJT/ HBT	◊	◊			
MOS					

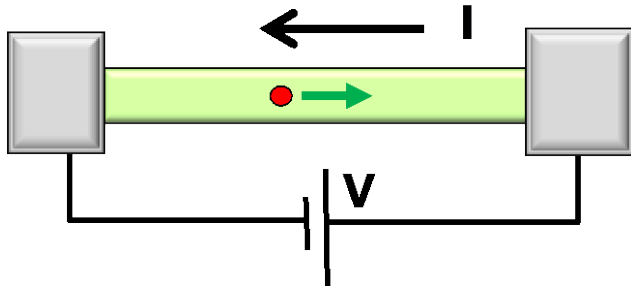
Minority & Majority Carrier Device

Majority Carrier Device
Thermionic Emission



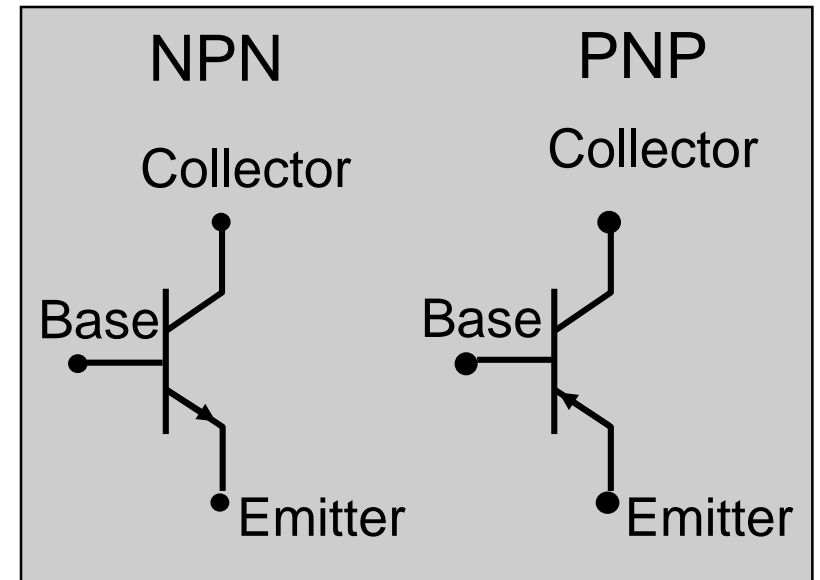
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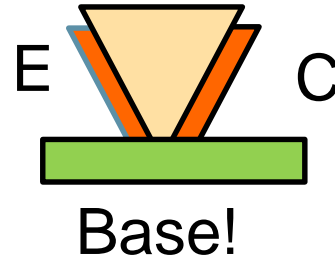
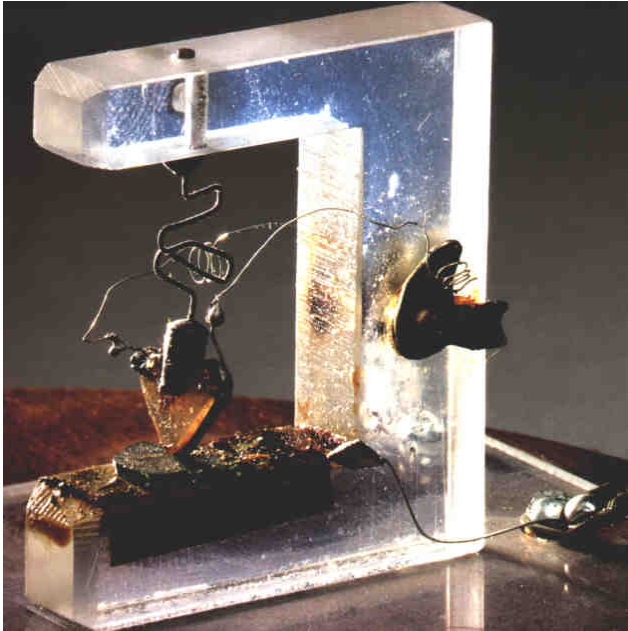
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charge density velocity area



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- > • 24.2 Band Diagram in Equilibrium
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Background



John Bardeen, William Shockley and Walter Brattain at Bell Labs

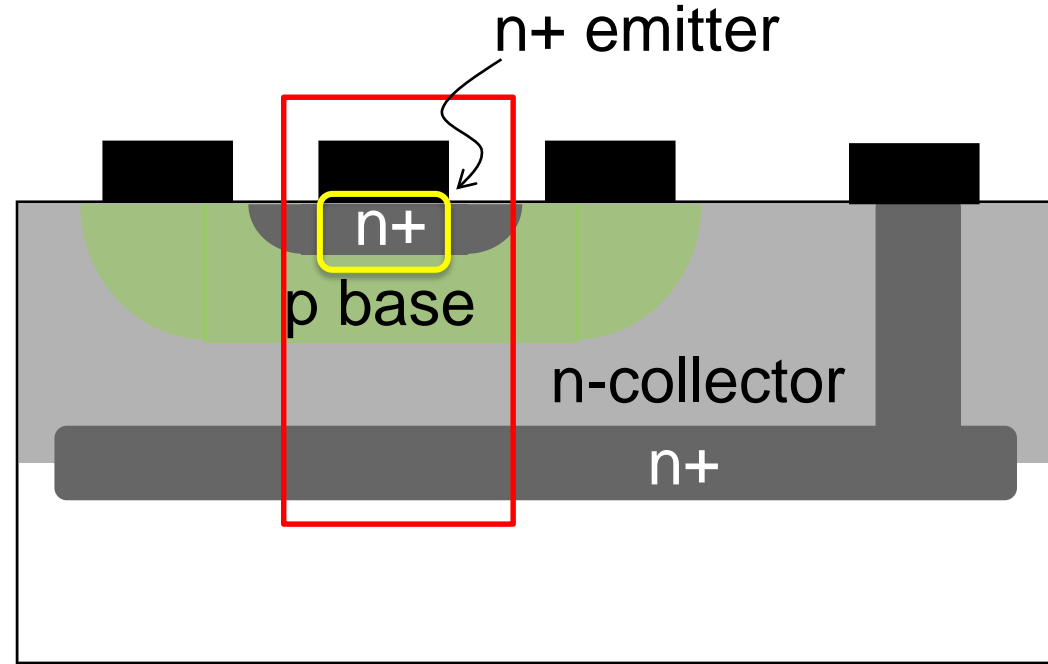
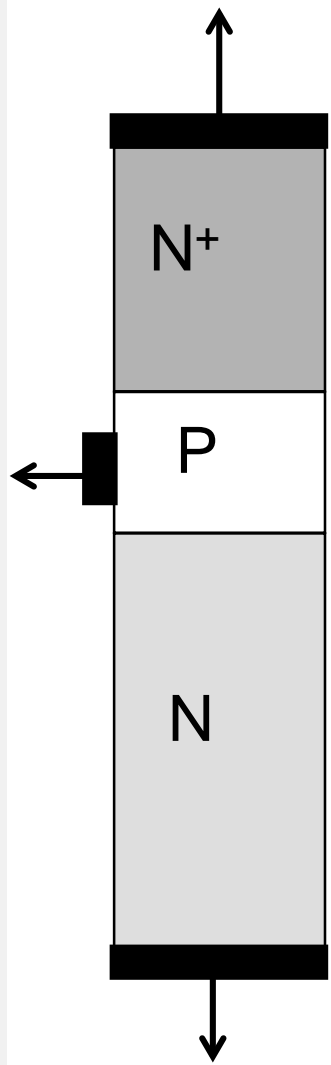
Point contact **Germanium** transistor

Ralph Bray from Purdue missed the invention of transistors.

http://www.physics.purdue.edu/about/history/semi_conductor_research.html

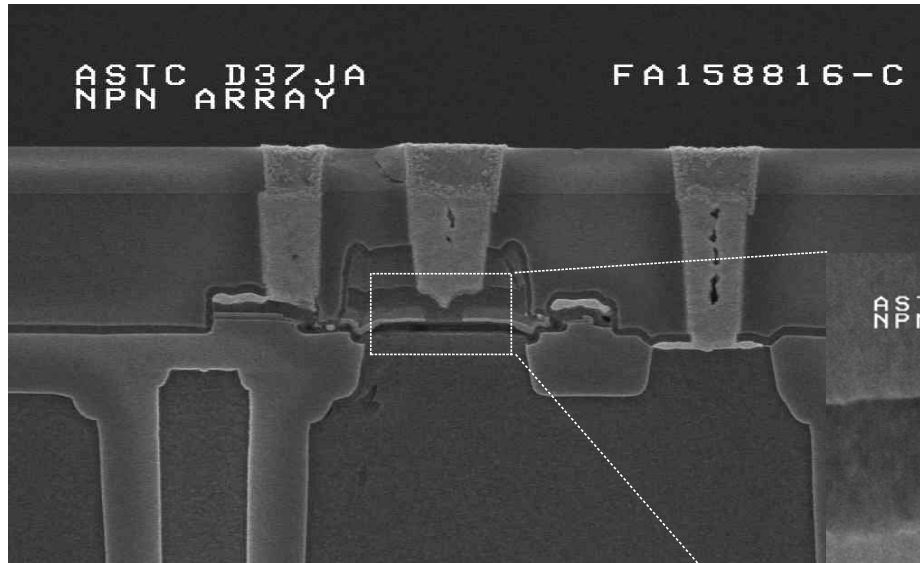
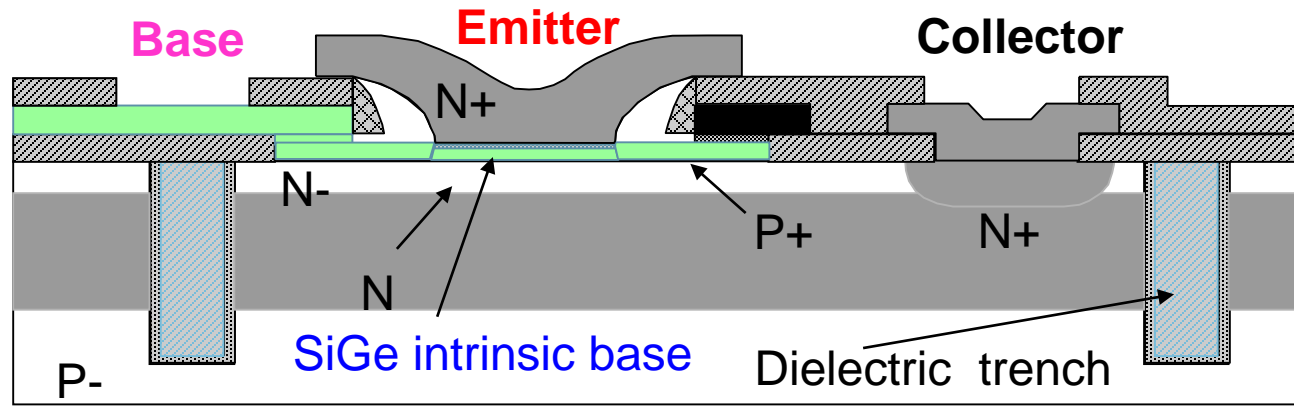
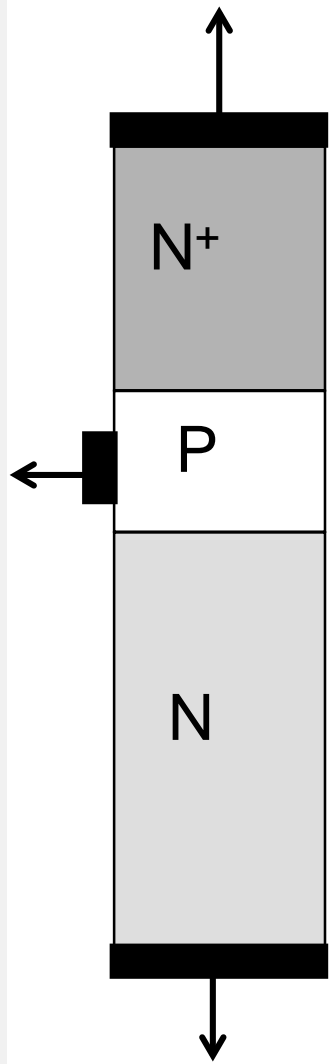
Transistor research was also in advanced stages in Europe (radar).

Shockley's Bipolar Transistors ...

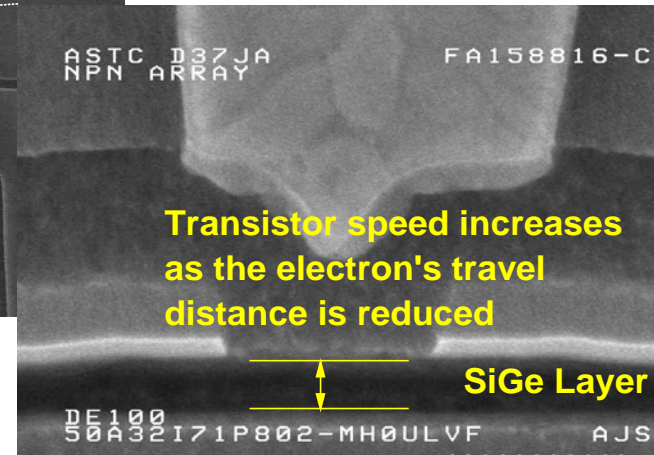


**Double
Diffused BJT**

Modern Bipolar Junction Transistors (BJTs)

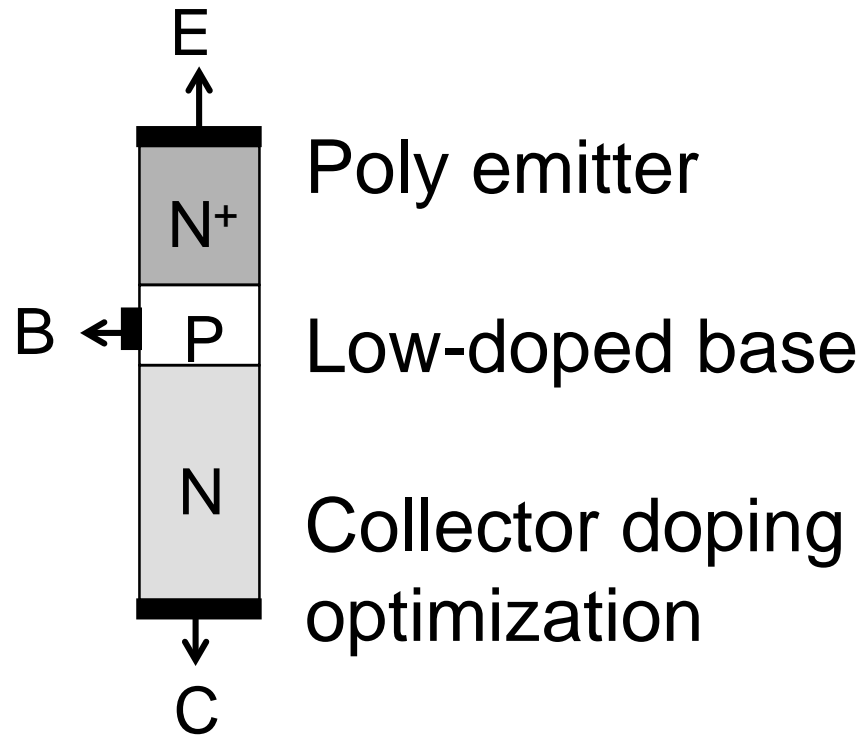


Why do we need all these design?

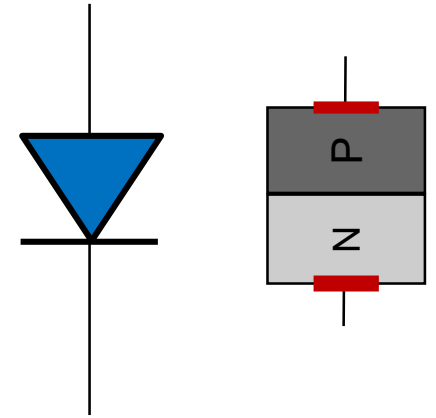
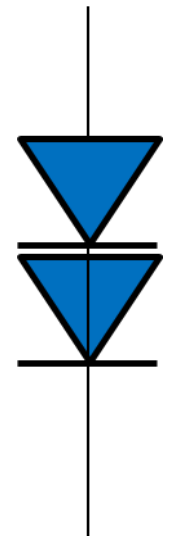
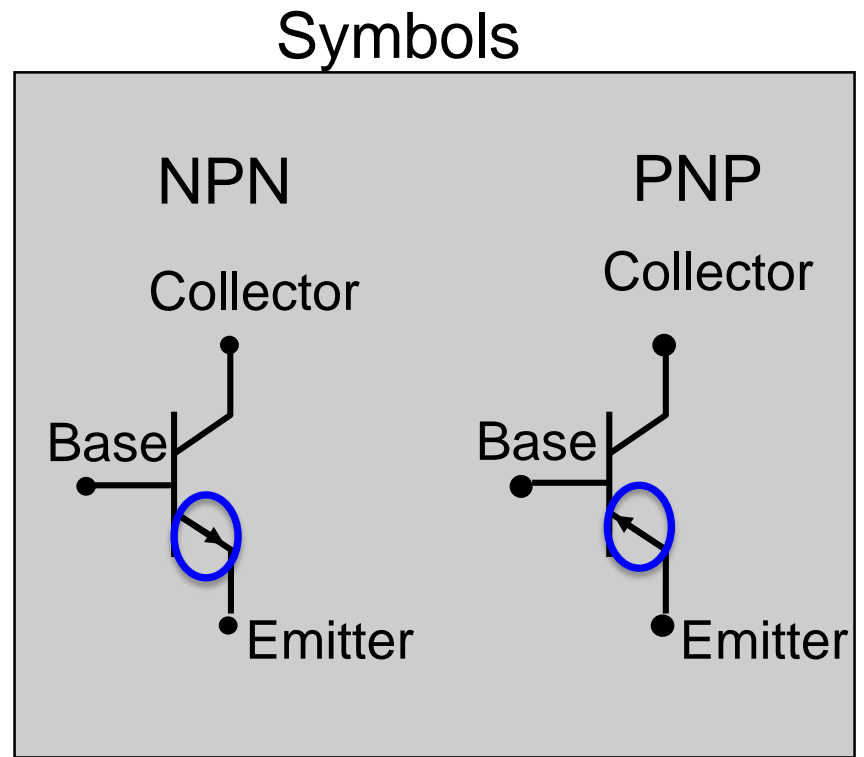


Transistor speed increases as the electron's travel distance is reduced

Symbols and Convention

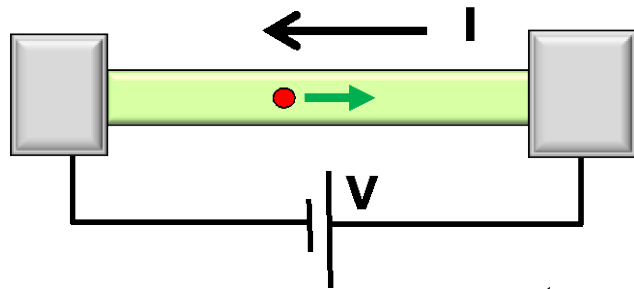


$$I_C + I_B + I_E = 0 \quad (\text{DC})$$
$$V_{EB} + V_{BC} + V_{CE} = 0$$



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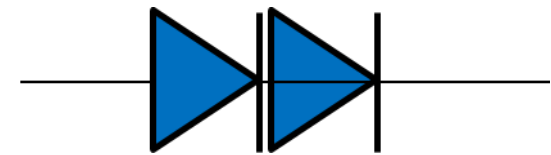
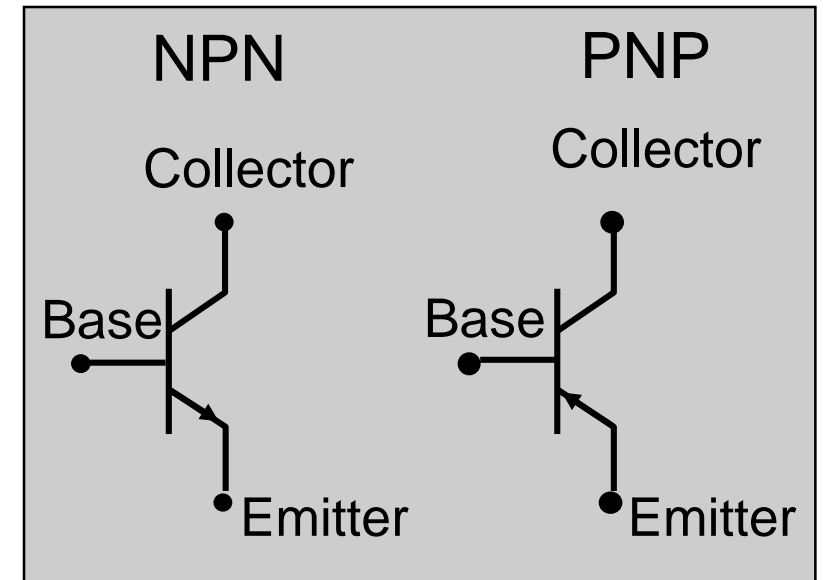


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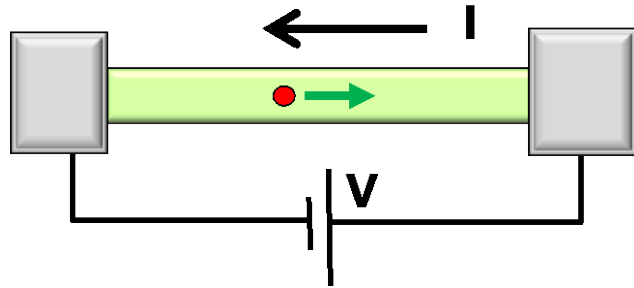
↑ charge density
 ↑ velocity
 area

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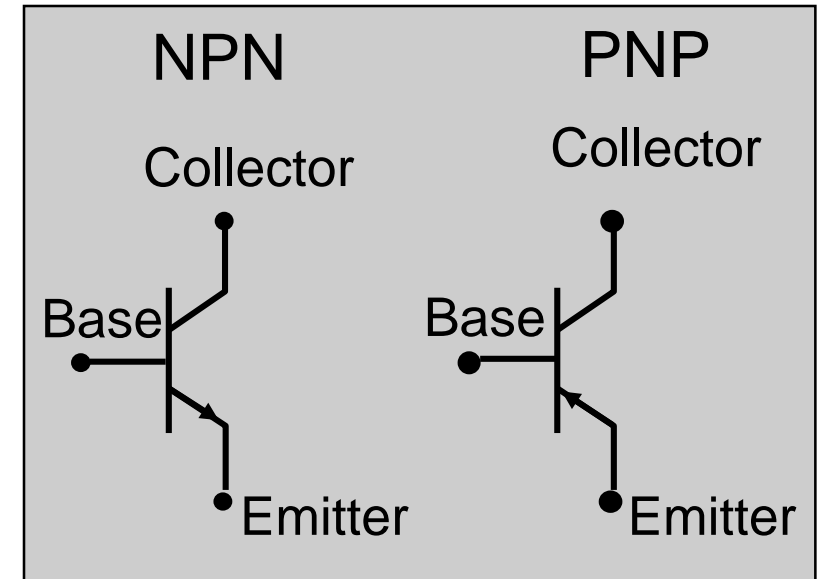


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Equilibrium

$$\nabla \cdot D = q(p - n + N_D^+ - N_A^-)$$

