



SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)
COIMBATORE-35

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

23EET104 / ANALOG ELECTRONICS I YEAR / II SEMESTER

UNIT-I: PN JUNCTION DEVICE

DIFFUSION AND TRANSITION CAPACITANCE



TOPIC OUTLINE



- ✓ Introduction
- ✓ Capacitance
- ✓ Types of capacitance in PN Junction diode
- ✓ Diffusion capacitance
- ✓ Transition capacitance

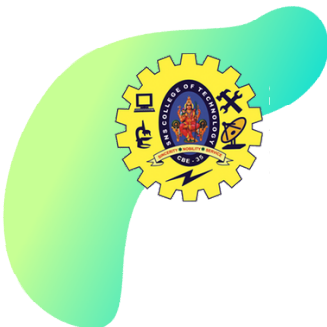




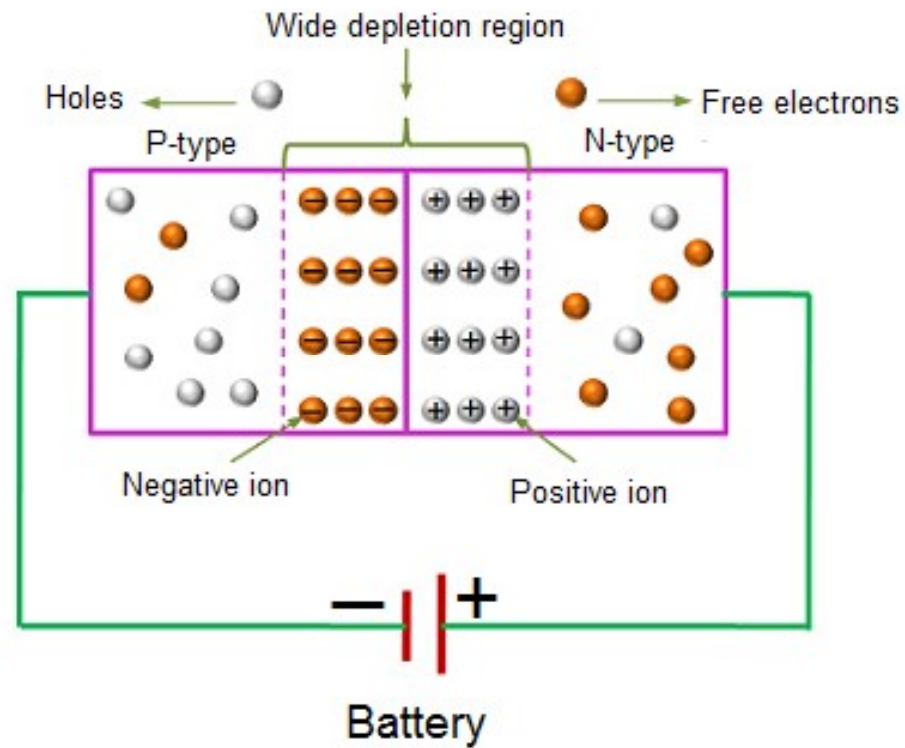
Capacitance

- In a p-n junction diode, two types of capacitance take place. They are,
- Transition capacitance (CT)
- Diffusion capacitance (CD)





Transition capacitance (CT)



Reverse bias





Contd...



- In a reverse biased diode, the transition capacitance exist. However, the transition capacitance is very small compared to the diffusion capacitance.
- Hence The **amount of capacitance changed with increase in voltage** is called transition capacitance.
- The transition capacitance is also known as depletion region capacitance, junction capacitance or barrier capacitance.
- Transition capacitance is denoted as C_T . e, transition capacitance is neglected in forward biased diode.





Contd...



- The change of capacitance at the depletion region can be defined as the change in electric charge per change in voltage.

$$C_T = dQ / dV$$

Where,

C_T = Transition capacitance

dQ = Change in electric charge

dV = Change in voltage





Contd...



The transition capacitance can be mathematically written as,

- $C_T = \epsilon A / W$
- Where,
- ϵ = Permittivity of the semiconductor
- A = Area of plates or p-type and n-type regions
- W = Width of depletion region





Diffusion capacitance (CD)

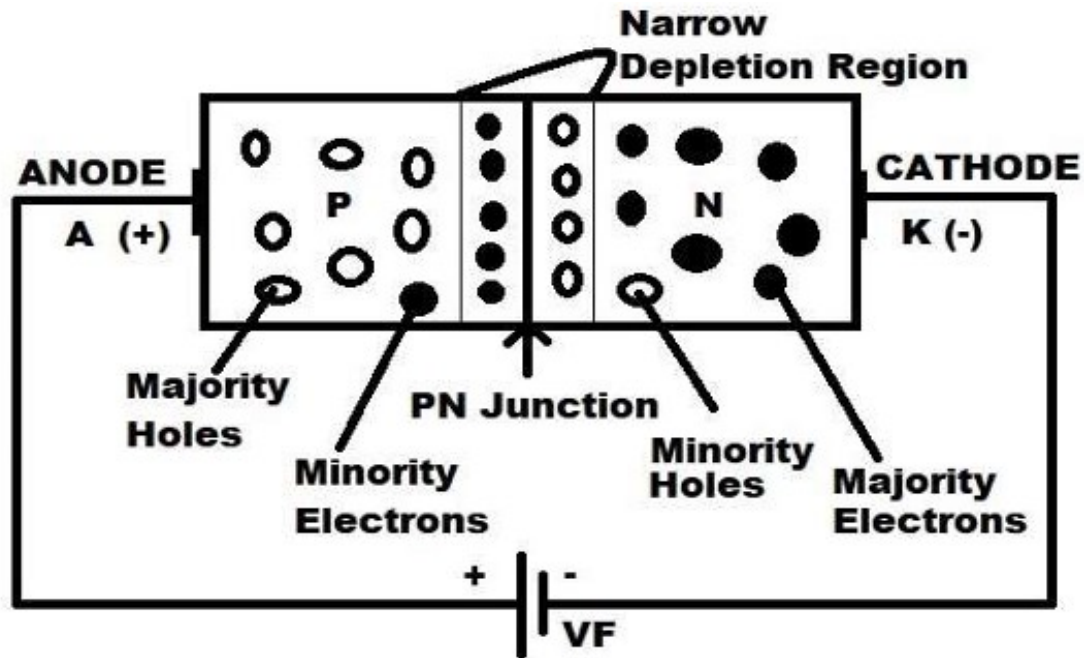


- Diffusion capacitance occurs in a forward biased p-n junction diode. Diffusion capacitance is also sometimes referred as storage capacitance.
- It is denoted as C_D .
- In a forward biased diode, diffusion capacitance is much larger than the transition capacitance. Hence, diffusion capacitance is considered in forward biased diode.
-





Diffusion capacitance (CD)



Contd...



- In the similar way, if small electric current flows through the diode, only a small amount of charge is accumulated near the depletion layer.
- As a result, small diffusion capacitance occurs.
- When the width of depletion region decreases, the diffusion capacitance increases.
- The diffusion capacitance value will be in the range of nano farads (nF) to micro farads (μF)





Contd..



The formula for diffusion capacitance is

$$C_D = dQ / dV$$

Where,

C_D = Diffusion capacitance

dQ = Change in number of minority carriers stored outside the depletion region

dV = Change in voltage applied across diode





MCQ



1. Diffusion capacitance is larger than transition capacitance.

- a) True
- b) False
- c) Both are same
- d) Depends on doping concentrations





ANSWER



- Answer: b

Explanation: Diffusion capacitance occurs in a forward biased diode, transition capacitance is easy to see in reverse bias. $C_D > C_T$ for a forward bias junction. In reverse bias though, C_D may be neglected compared to C_T .





MCQ



2. For a diode the transition capacitance was 10pF . The depletion width changed from $1\mu\text{m}$ to $10\mu\text{m}$. All other conditions remain unchanged. The new diode capacitance is _____

- a) 5pF
- b) 1.414pF
- c) 1pF
- d) 10pF





ANSWER



- Answer: c

Explanation: The equation of transition capacitance = $\epsilon A/W$

Where ϵ = permittivity of the material of diode, W = depletion width

A = area of cross section

Since depletion width increased 10 times and all other quantities are the same, the capacitance decrease by 10 times.





MCQ

3. A diode had a transition capacitance of 1 pF and depletion width of 1 μm . The capacitance changes to 10 pF when the depletion width changes. The final depletion width is _____

- a) 10 μm
- b) 0.1 μm
- c) 1 μm
- d) 100 μm



ANSWER



3. Answer: b

Explanation: The equation of transition capacitance = $\epsilon A/W$

Where ϵ = permittivity of the material of diode, W = depletion width

A = area of cross section

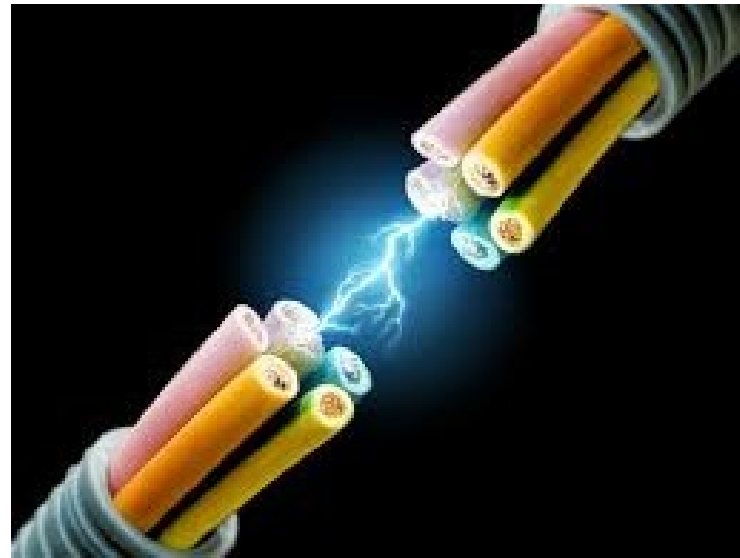
Since depletion width and capacitance are inversely proportional

Depletion width decreases to $0.1 \mu\text{m}$.





RECAP....



...THANK YOU

