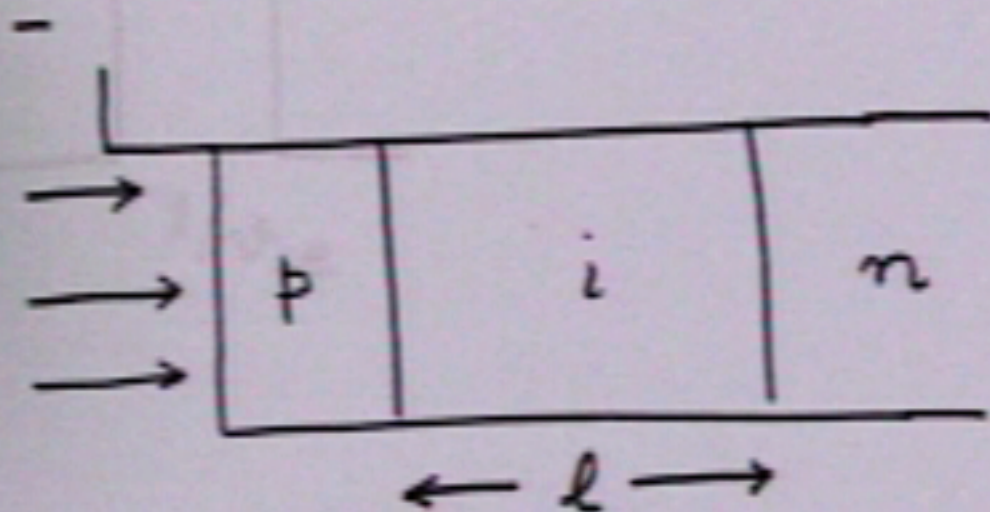


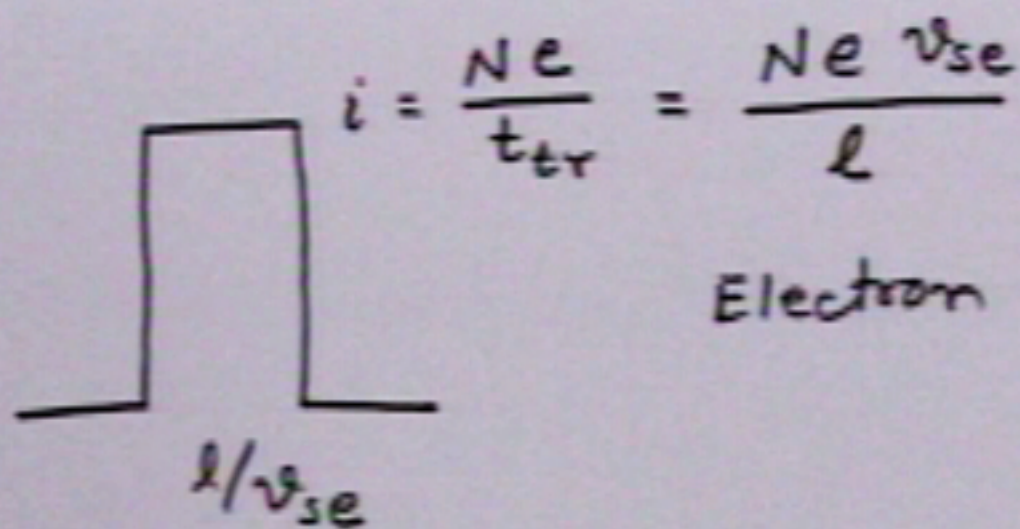
## RESPONSE TIME



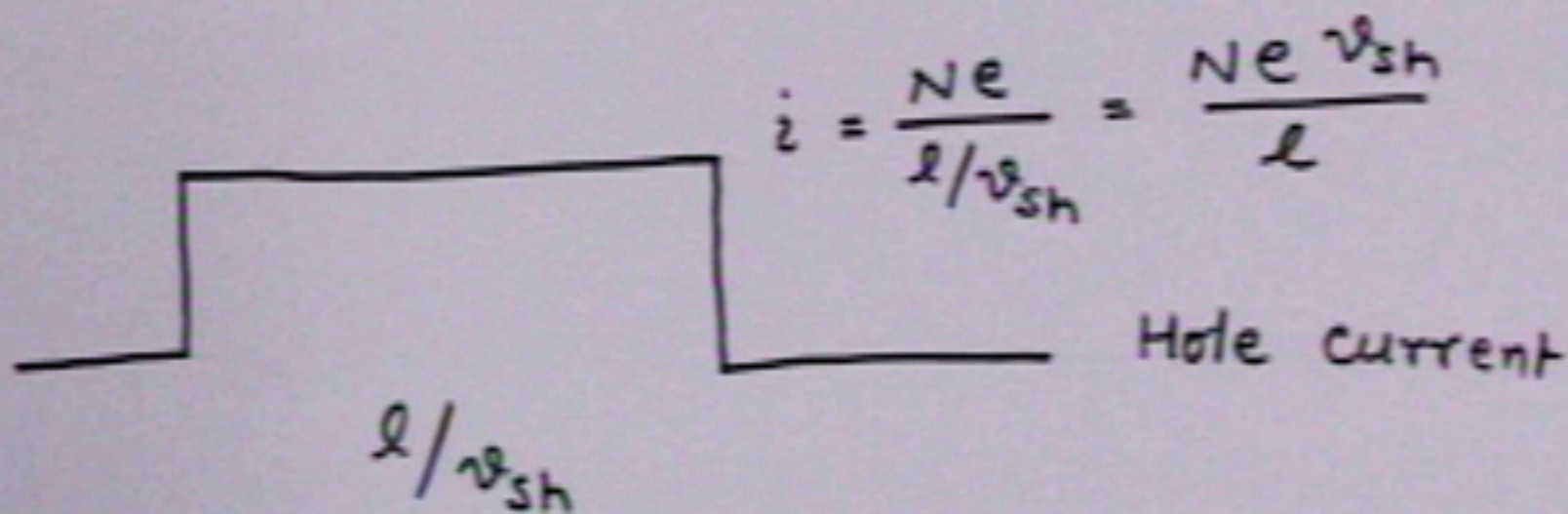
$N$  - electrons.

$v_{se}$  = saturation velocity

$$t_{tr} = \frac{l}{v_{se}} = \text{Transit Time}$$

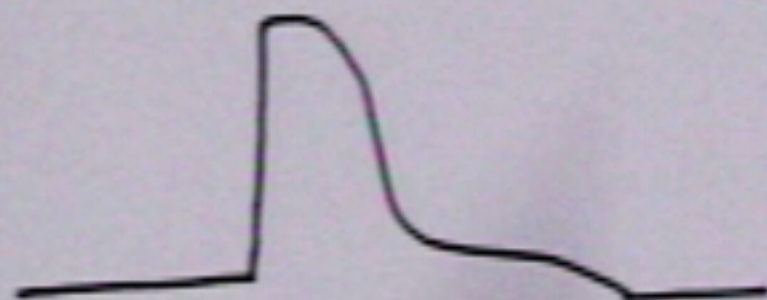
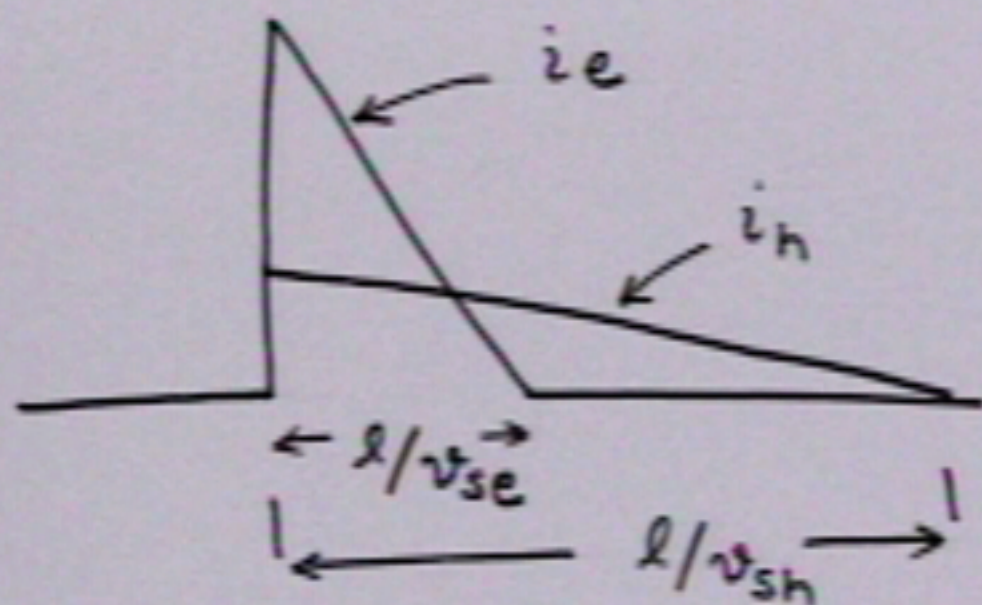


Electron current

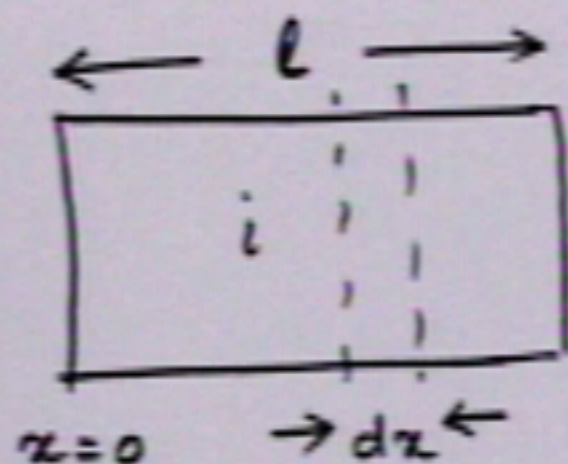


Hole current

Uniform carrier generation



Photon flux  $\phi(t) = \phi_0 (1 + m \sin \omega t)$



$$N_0 \left\{ 1 + m \sin \omega \left( t - \frac{x}{v_{se}} \right) \right\} dt$$

$$dt = \frac{dx}{v_{se}}$$

Total carriers in transit

$$N = \int_0^l \frac{N_0}{v_{se}} \left\{ 1 + m \sin \omega \left( t - \frac{x}{v_{se}} \right) \right\} dx$$

$$= \frac{N_0 l}{v_{se}} + \frac{m N_0}{\omega} \left\{ \cos \omega \left( t - \frac{l}{v_{se}} \right) - \cos \omega t \right\}$$

$$= \frac{N_0 l}{v_{se}} \left\{ 1 + \frac{2 m v_{se}}{\omega l} \sin \frac{\omega l}{2 v_{se}} \cdot \sin \omega \left( t - \frac{l}{2 v_{se}} \right) \right\}$$

Current in the external ckt

$$i = \frac{N e v_{se}}{l}$$

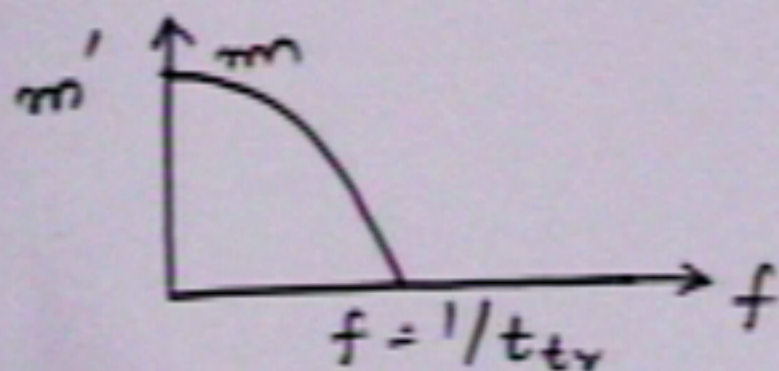
Transit time  $t_{tr} = l/v_{se}$

$$\omega = 2\pi f$$

$$i = N_0 e \left\{ 1 + m \frac{\sin(\pi f t_{tr})}{\pi f t_{tr}} \sin 2\pi f \left( t - \frac{t_{tr}}{2} \right) \right\}$$

modulation index

$$m' = m \frac{\sin \pi f t_{tr}}{\pi f t_{tr}}$$



$$t_{tr} \approx 0.5 \text{ msec}$$

$$f_{max} \approx \frac{0.44}{t_{tr}} = 880 \text{ MHz}$$

⇒ Response time of Photo detector :

Depends upon :-

1. Transit time of carrier in Depletion region.
2. Diffusion time of photo carriers generated outside depletion region.
3. RC time constant of diode and associated circuitry.



⇒ **Parameters Responsible :**

**Absorption coefficient ( $\alpha$ )**

**Depletion region width ( $W$ )**

**Junction and package capacitance ( $C_j$ )**

**Amplifier Capacitance ( $C_a$ )**

**Detector load resistance ( $R_L$ )**

**Amplifier input resistance ( $R_a$ )**

**$W \gg 1/\alpha$  for high quantum efficiency**

**Large  $W$  will increase drift time**

**Small  $W$  will increase diffusion time of carriers**

**Small  $W$  will increase  $C_j \Rightarrow$  Large RC time constant**