PHOTO DETECTOR

- **A device which converts optical signal into electrical current:**
- **REQUIREMENTS :**

1. **High Sensitivity**
2. **Fast Response**
3. **Wide Bandwidth**
4. **Insensitive to Temperature Variation**
5. **Minimum addition of noise**
6. **Compatible with fiber dimensions**
7. **Cost**
8. **Long operating life**

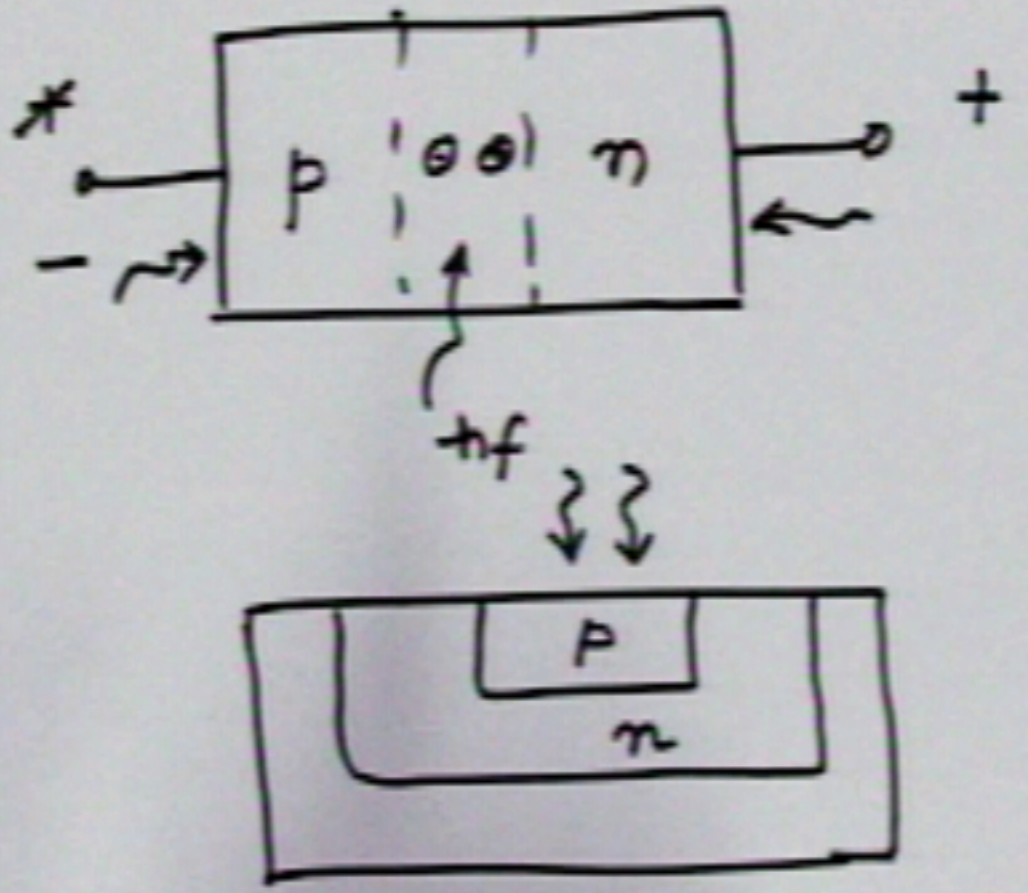
- Photo multipliers, photo conductors, **photo diodes**.

Responsivity $\mathcal{R} \equiv \frac{I_p}{P_o} = \frac{\mu A}{\mu W}$.

Quantum efficiency

$$\eta = \frac{\text{No. of e-h pairs generated}}{\text{No. of incident photons}}$$

$$= \frac{I_p / q}{P_o / hf}$$


p
n
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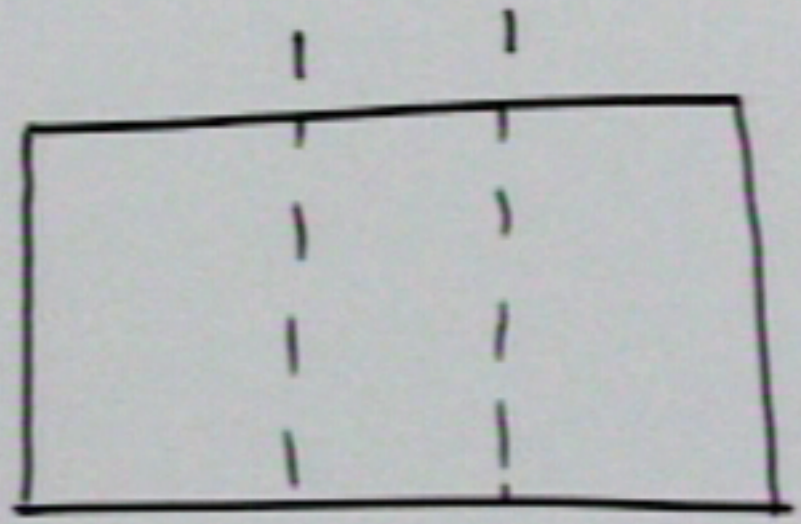
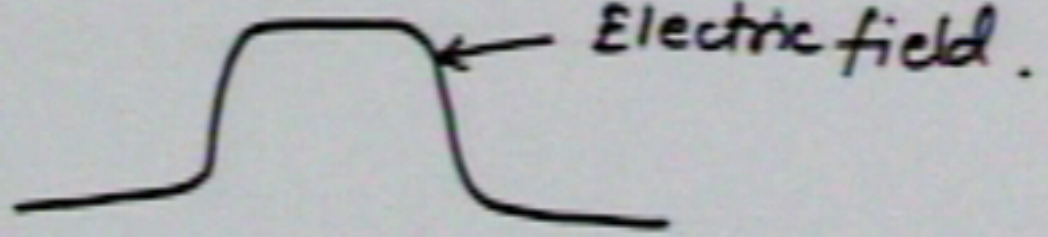
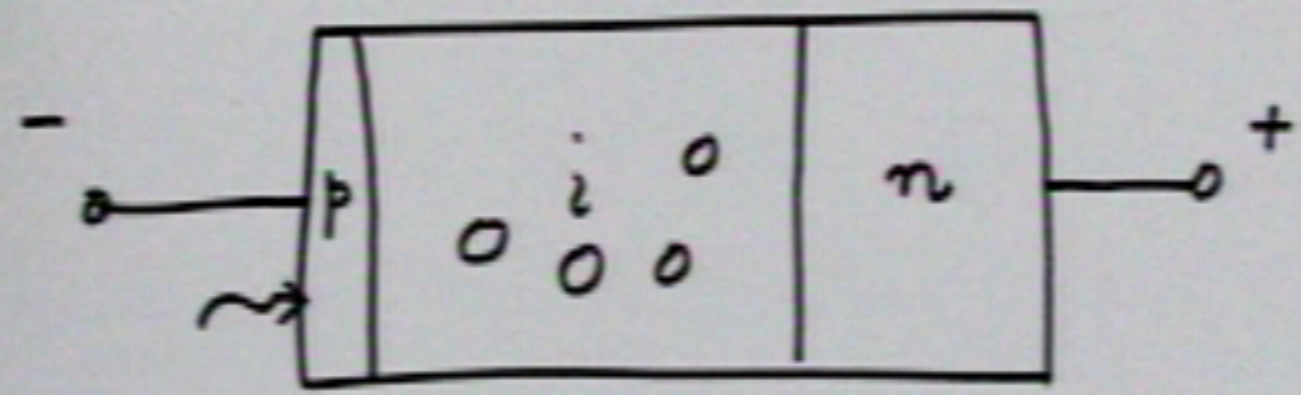



Electric field.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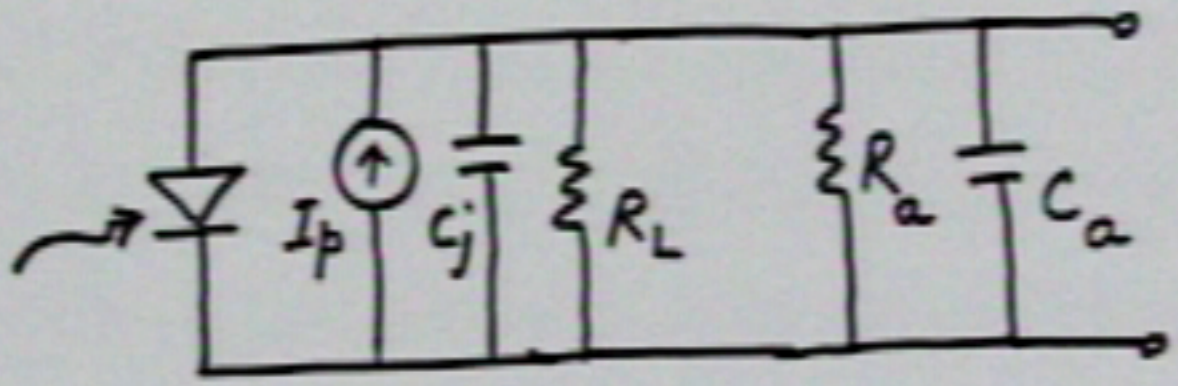
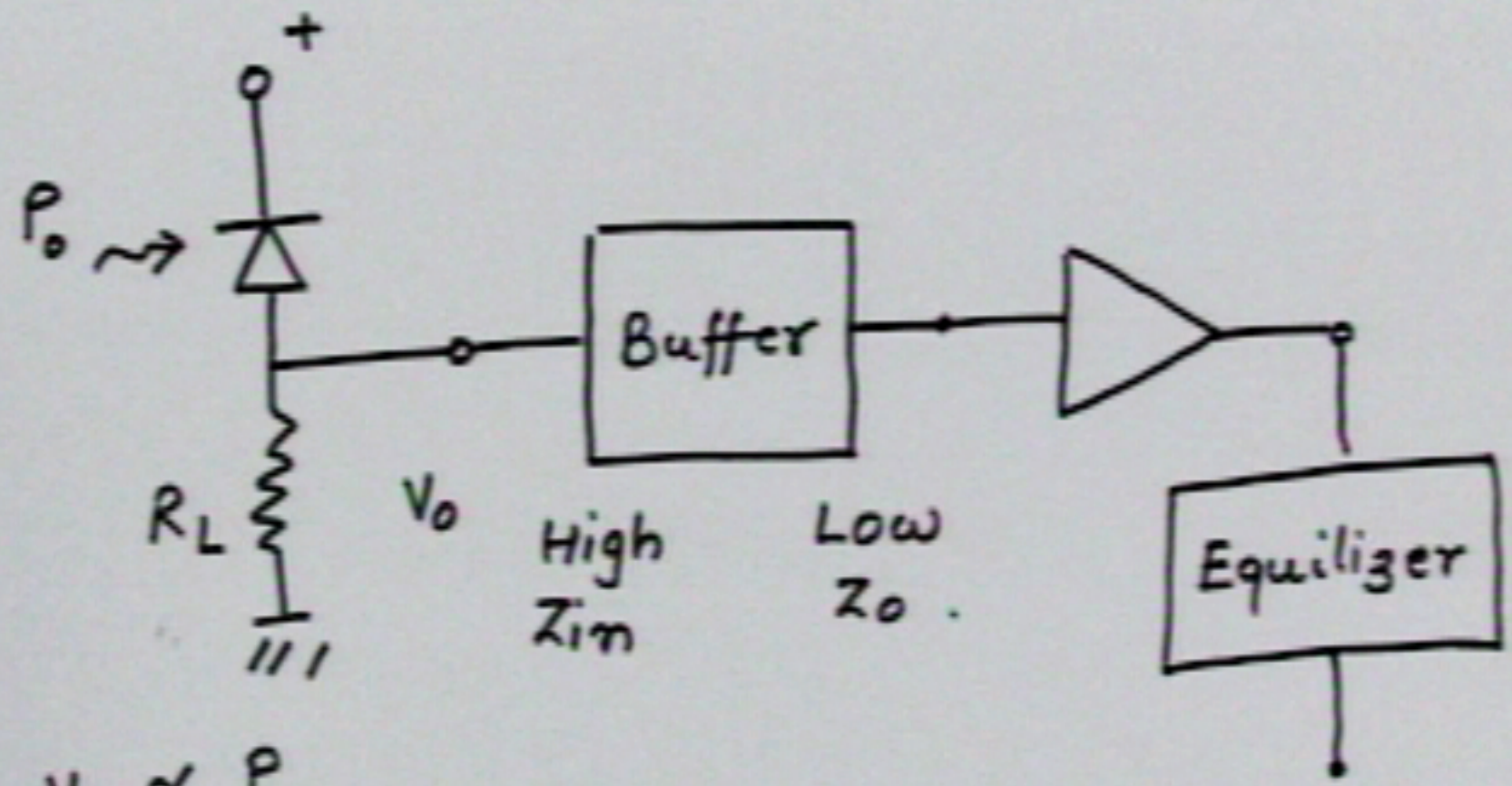
AC. Equivalent ckt.



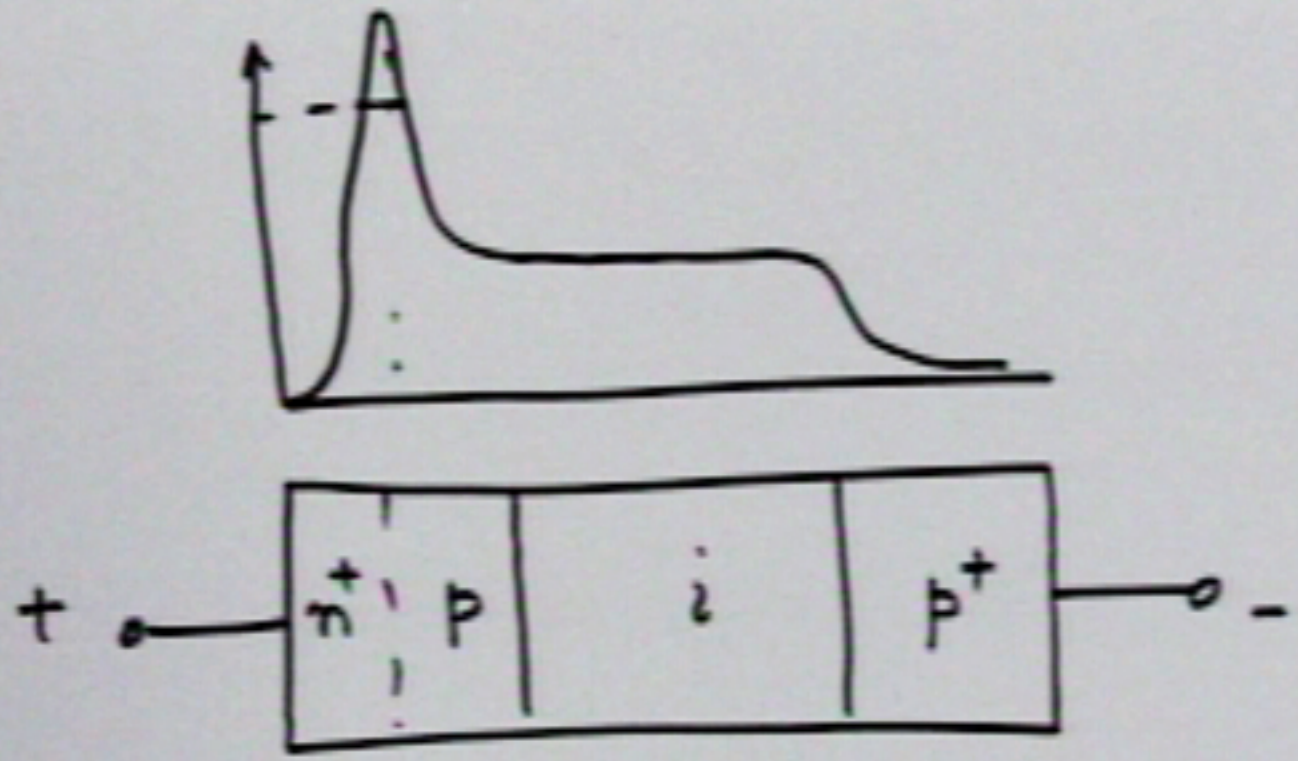
$$R_{eff} = R_L \,||\, R_a$$

$$C_{eff} = C_a + C_j$$

$$\text{Time const} = R_{eff} \cdot C_{eff}$$



$V_o \propto P_o$



Avalanche photo diode.

Noise in photo Detector

1. Quantum or shot Noise

$$\langle i_Q^2 \rangle = 2 q I_p B M^2 F(M)$$

B: Bandwidth; $M^2 F(M)$: Avalanche detector

2. Dark current Noise

Bulk: $\langle i_{DB}^2 \rangle = 2 q I_B M^2 F(M) B$

Surface: $\langle i_{DS}^2 \rangle = 2 q I_S B$

3 Thermal Noise:

$$\langle i_T^2 \rangle = 4 K T B / R_L$$

Signal power $= \langle i_p^2 \rangle M^2$

Signal to Noise Ratio

$$SNR = \frac{\langle i_p^2 \rangle M^2}{\langle i_Q^2 \rangle + \langle i_{DB}^2 \rangle + \langle i_{DS}^2 \rangle + \langle i_T^2 \rangle}$$