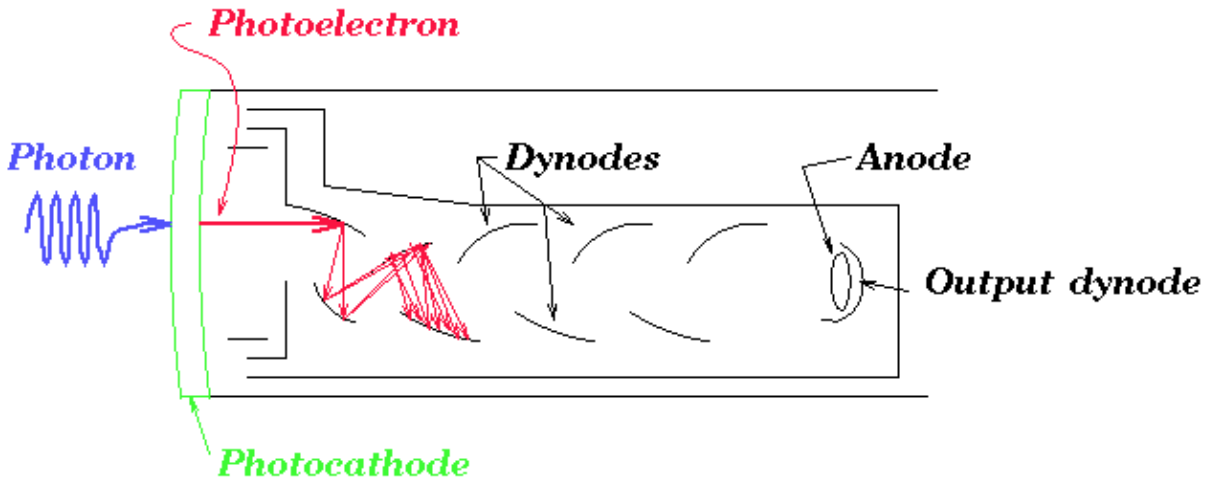
UNIT – 1

SCIENCE OF MEASUREMENT AND TRANSDUCERS

Photomultiplier Tube

Basic Photomultiplier Tube (PMT Struct

1. Photocathode
2. Electron Optical Input System
3. Electron Multiplier
4. Anode



The Photocathode

Photocathode converts incident photons to photoelectrons

Emitted electron energy given by Einstein's photoelectric affect:

$$E = h\upsilon - \phi$$

Must reach minimum frequency for equation to be applicable

Photocathode Values

1. Quantum Efficiency:

$$\eta(\lambda) = \frac{N_{photoelectrons}}{N_{photons}(\lambda)}$$

2. Radiant Cathode Sensitivity:

$$S(\lambda) = \frac{I_k}{P(\lambda)}$$

Photocathode Values

Or:

$$S(\lambda) = \lambda \eta(\lambda) \frac{e}{hc}$$

For Units in Amperes/Watts

Or: Luminous Cathode Sensitivity
(Not Recommended)

Photocathode Values

- Energy Loss given by Escape Depth

$$\Delta E \simeq x \frac{dE}{dx}$$

- Most materials η(λ): 0.1%
- Semiconductors η(λ): 10%-30%
- Negative Electron Affinity Metals η(λ): ≤80%

Electron Optical Input System

- Two electrodes guide electrons to first dynode using an electric field
- Focusing electrode on the sides of the PMT
- Accelerating electrode by first dynode
- Two requirements:

  1) As efficient as possible

  2) Uniform time from cathode to dynode

Electron Multiplier Section

- Secondary emission electrodes (dynodes)
- Each has secondary emission factor δ
- Like photocathode, but with incident electrons and E-field
- Dynode material requirements:
  1) High δ
  2) Stability of emission even with current
  3) Low thermionic emission
- Use 10-14 stages with total Gain ≈ 10^7
- Use negative electron affinity metals

Electron Multiplier Section

- Dynode Configurations:
  a) Venetian Blind
  b) Box and Grid
  c) Linear focused
  d) Side-On Configuration