UNIT – III

OPTICAL DETECTION DEVICES

PART A

1.What is a photodiode?

A photodiode is a reverse biased diode which absorbs light &converts it into charge carriers or electric current.

2.What are the properties of photodiodes? { MAY-12]

Every photodiode should have low dark current , wide wavelength response &high quantum efficiency .it should have low rise time &fast response.

3.What is meant by binary digital modulation?

The analog signal is sampled and binary coded in the form of "ones"and "zeros.

4.State franz –keldysh effect.

Franz –keldysh effect refers to the absorption of photons having energies less than the bandgap of the semiconductor by means of applying a strong electric field.

5.State stark effect.

Stark effect refers to the energy shift and corresponding electron tunneling by absorption of photons whose energy is less then the band gap of the semiconductor by means of applying a strong electric field.

6.What are the different factors that determine the response time of photodetector? { MAY-12]

(i) transit time of charge carriers
(ii)diffusion time of charge carriers
(iii) time constant RC of the photo detector circuit.

7.What are the condition for total internal reflection.

(i) Light should travel from denser medium to rarer medium.
(ii)the angle of incidence should be greater then the critical angle of the denser medium.

8.Define V-number of fiber.

V-number of fiber indicates the number of possible propagation modes in the core

$$V=2\pi/\lambda a(N.A)$$

Number of propagating modes through the step index fiber $N=V^2/2$

9.What are the different noises present in the avalanche photodiode? { MAY-12]

(i)quantum noise ,(ii)dark current noise (iii)thermal noise and (iv)avalanche multiplication.

10.What are the required properties of photo detector?

(i)high quantum efficiency.
(ii) low rise time or fast response
(iii)low dark current.

11.Explain thermal detectors.

Thermal detectors are devices that work by absorbing the incident photon. It consists of a sensing element and an heat sink connected to it. The sensing element will absorb the photon, which results in production of heat. This heat produced will increases the temperature of heat sink connected to it.

12. What is the internal quantum efficiency of photodetector?

efficiency is also known as responsivity. It is defined as the ratio of the number of photo generated carriers to incident photons and thus a unit less quantity.

η= Number of corresponding electrons in the external circuit/ Number of incident photons

13. Explain photoconductors.

It is the simplest optical detector. It exhibits an internal gain mechanism. It also clearly demonstrates the gain-bandwidth limitations. Its operation is based on the increase in conductivity of specific region with photon excitation. The generated electrons and holes arecollected at opposite end and results in photocurrent.

14. What do you mean by Kerr effect?

Magneto-optic Kerr effect (MOKE) is one of the magneto-optic effects. It describes the changes of light reflected from magnetized media. The light that is reflected from a magnetized surface can change in both polarization and reflected intensity. The effect is identical to the Faraday effect except that the magneto-optical

Kerr effect is a measurement of the reflected light, while the Faraday effect is a measurement of the transmitted light.

15. What are the different types of photodetectors?

The different types of photodetectors are,

- ✓ Photoconductors
- ✓ Pin diodes
- ✓ Avalanche photodiode
- ✓ Intrinsic photodetectors
- ✓ Extrinsic photodetectors

16. What are the factors that limit the response time of photodiodes? NOV/DEC2016

The factors that limit the response time of photodiodes are,

- Diffusion time of carriers to the depletion region
- Drift time of carriers to the depletion region
- Junction capacitance effects

17. Define noise equivalent power.

It is defined as the power of sinusoidally modulated chromatic radiation, which would result in the same root mean square output signal in an ideal noise free detector as the noise signal encountered in the real detector. If we assume that noise power generated in a detector is proportional to its sensitive area A, then the noise current will vary as A1/2. Here we define a new unit NEP* and it can be written as

$$NEP^* = NEP/(A\Delta f)^{1/2}$$

The reciprocal of this is known as specific detectivity D* and it is written as

$$D^* = (A\Delta f)^{1/2}/NEP$$

18. Discuss briefly about pin photodiode.

A PIN diode is a diode with a wide, lightly doped 'near' intrinsic semiconductor region between a p-type semiconductor and an n-type semiconductor region. The p-

type and n-type regions are typically heavily doped because they are used for ohmic contacts.

19. Define Pockels effect.

The Pockels effect or Pockels electro-optic effect, produces birefringence in an optical medium induced by a constant or varying electric field. It is distinguished from the Kerr effect by the fact that the birefringence is proportional to the electric field, whereas in the Kerr effect it is quadratic in the field. The Pockels effect occurs only in crystals that lack inversion symmetry, such as lithium or gallium arsenide and in other concentrate symmetric media such as electric-field poled polymers or glasses.

20. What is the working principle of thermal detectors?

Thermal detectors are devices that work by absorbing the incident photon. It consists of a sensing element and an heat sink connected to it. The sensing element will absorb the photon, which results in production of heat. This heat produced will increases the temperature of heat sink connected to it.

PART - B

1. **Explain in detail the principle, construction, working and of a thermal detector and a photo conductive detector. [May/June-2013] NOV/DEC 2016**

- Principle,
- Construction,
- Working
- Diagram
- Equation

2. Explain the principle, construction and working of pyro-electric detector. NOV/DEC2016

- Principle,
- Construction,
- Working
- Diagram

- Equivalent circuit

3. Explain the principle and operation of photo transistors

- Principle,
- Construction,
- Working
- Diagram
- Equation
- Structure of Photo transistor

4. with an equivalent circuit, explain the factors affecting the bandwidth of a PIN photodiode. [May/June-2013] APR/MAY 2017

- Principle
- Equivalent circuit
- Structure
- Equation
- Graph

5. Brief about the various noise sources in a photo multiplier tube.[May/June-2013]

- Definition
- Construction
- Structures of four common types of photomultiplier
- Equation
- Dynode biasing circuit

6. Explain in Silicon Photo diode and its Characteristics.

- Definition
- Construction
- Diagram
- Characteristics