ST. ANNE'S

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QUESTION BANK

PERIOD : June 2019 – Dec 2019 **BATCH**: 2016 – 2020

BRANCH : ECE **YEAR/SEM:** IV/VII

SUBJECT: EC6016-Opto Electronic Devices

UNIT – I

ELEMENTS OF LIGHT AMD SOLID STATE PHYSICS

PART – A

1. Define optoelectronics.[D]

Optoelectronics is the branch of technology concerned with combined use of electronics and light. It can be defined as the study and application of electronic devices that source, detect, and control light. Optoelectronics can be considered as the subfield of photonics. Photonics includes the generation, emission, transmission, modulation, signal processing, amplification, detection, and sensing of light.

2. What is meant by Polarization and what are the two methods of polarization[D]

If the electric field vector of an EM wave propagation in free space vibrates in a specified plane, the wave is said to be plane polarized. Any real beam of light comprises many individual waves and in general the plane vibration of their electric fields will be randomly oriented. Such beam of light is un polarized and the resultant electric field vector changes orientation randomly in time. The light beams characterized by highly oriented electric fields and such light is referred as being polarized.
Polarization Methods:
1.Reflection
2.Absorption

3. What do you meant by interference? [NOV/DEC 2016] [D]

It can be defined as the superimposition or mixing up of 2 or more waves which results in forming another new wave. Interference is denoted as I.

4. State Malus Law[D]

Malus stated that the intensity of polarized light transmitted through the analyser varies as the square of cosine of the angle between the plane of transmission of the analyser and the plane of polarizer $I1 = I0\ cos2\theta$

5.Distinguish fresnel and fraunhofer diffractions[D]

S.NO	FRESNEL DIFFRACTION	FRAUNHOFER DIFFRACTION

1	Either point source or an illuminated narrow slit is used	Extended source at infinite distance is Used
2	Wavefront undergoing diffractions is either spherical or cylindrical	Wavefront undergoing diffraction is a plane wavefront
3	Source and screen are at finite distance from the diffraction production	Source and screen are at infinite distance from the diffraction production
4	No lens is used to focus the lens	Converging lens is used to focus the parallel lens

6. Define radiative recombination and non-radiative recombination process. [Apr/May 2016] [D]

When temperature rises up, if a photon is released then that type of process is known as radiative recombination. If no emission of photon occurs, then that type of process is known as non-radiative process.

7. Differentiate diffraction and scattering[D]

 Diffraction is a phenomenon observed only in waves, but scattering is phenomenon observed in both waves and particles
 Diffraction is a property of propagation of waves ,where as scattering is a property of wave interactions
 Diffraction can be taken as evidence for the wave nature of light. Some forms of scattering (Compton scattering) can be taken as evidence for the particle nature of light.

8. Differentiate between coherent and incoherent light[D]

Coherent light is light in which the photons are all in 'step' – other words the change of phase within the beam occurs for all the photons at the same time. There are no abrupt phase changes within the beam. Light produced by lasers is both coherent and monochromatic (of one 'colour').

Incoherent sources emit light with frequent and random changes of phase between the photons. (Tungsten filament lamps and 'ordinary' fluorescent tubes emit incoherent light).

9. Define snell's law[D]

Snell's law can be defined as the refractive indices between two media will be equal

$$n1 \sin \Theta 1 = n2 \sin \Theta 2$$

10. What are black body radiators? [D]

Black body sources are opaque bodies or hot dense glasses which radiate energy in all wavelengths. These sources absorb all components and allow only black components.

11. What are semiconductors? [D]

The materials whose electrical property lies between those of conductors and insulators are known as Semiconductors. Ex germanium, silicon.

It has two types.
1.Intrinsic semiconductor
2. Extrinsic semiconductor.

12. What are intrinsic semiconductors? [D]

Intrinsic semiconductors are semiconductor crystals which contain no impurities or lattice defects. In this material there are no charge carriers. As temperature rises, electron-hole pairs are generated. The value of n material varies exponentially with temperature and this acts as the charge carriers in intrinsic semiconductor.

13.What are extrinsic semiconductors? [D]

Extrinsic semiconductors are semiconductors formed by the process called doping. Doping increases the number of charge carriers. Doping refers to adding appropriate amount of impurities to increase conductivity of material. By doping, we can either make n-type material or a p-type material. In n-type material the majority carriers are electrons and in p-type material the majority carriers are holes.

14. Differentiate between intrinsic and extrinsic semiconductor [Apr/May 2017] [D]

Pure form of semiconductors are said to be intrinsic semiconductor.
Ex: germanium, silicon.

- It has poor conductivity
- If certain amount of impurity atom is added to intrinsic semiconductor the resulting semiconductor is Extrinsic or impure Semiconductor
- It has good conductivity.

15. What are light sources and name the different types of light sources? [D]

Light sources are also known as thermal sources or classical sources. All light sources are related to light. These sources are named like this because they radiate electromagnetic energy in direct relation to their temperature.
Light sources are divided into two namely, blackbody sources and line sources.

16. What do you understand by the quantum mechanical concepts of light? [Apr/May 2018] [D]

Quantum mechanical concepts of light suggest three concepts. The first one is light possesses dual nature i.e., it has both particle and wave nature. The second concept is the amplitude of wave is related to the probability of locating the particle in a given region of space. The third concept is the wave function has to be find out. Wave function can be defined as probability of finding particle in the region of space between x and x+dx, y and y+dy, and z+dz.

- Wave function 'Ψ' is given as Ψ* Ψdxdydz.

17.Define Stehen Boltzmann law[D] [Nov/Dec 2018]

It is defined that the rate at which energy is emitted is proportional to the fourth power of the absolute temperature

$$W=\sigma\varepsilon T^4$$

σ= stefen's constant
ε= emissivity of the surface
T=absolute temperature

18. Define Wein's displacement law. [Nov/Dec 2018] [D]

It is defined as that the spectral distribution of the energy emitted at a given temperature has a definite maximum and this maximum shifts to shorter wavelengths as the temperature increases.

$$\lambda_m T = \text{constant}$$

19. Identify the following as intrinsic and extrinsic semiconductors[D] [Apr/May 2019]
a)p-Si
b)Ge
c)GaAs
d)pn junction
Ans:
p-Si: Extrinsic Semiconductor
Ge : intrinsic Semiconductor
GaAs: intrinsic Semiconductor
Pn junc: Extrinsic Semiconductor

20. Give the expression for electrical conductivity of a semiconductor. [Apr/May 2019] [D]

$$\sigma = [p\mu_h + n\mu_e]e$$

PART – B

1.From the Schrodinger equation, explain the formation of energy bands in solids. **[May/June-2013] [Nov/Dec2016] [D]**

2. Derive the expression for concentration of electrons and holes in an intrinsic semiconductor, with relevant diagrams**. [May/June-2013] [Apr/May 2017] [D]**

3. Explain
i).Wave nature of light and the principle of superposition **[Nov/Dec-2013] [Nov/Dec 2016] [D]**
ii).With a neat diagram explain the interference effects in a thin film of refractive index "n" **[Apr/May 2018]**

4.Explain in detail about the excess carriers in semiconductors and hence derive an expression for the variation of excess carriers concentration with distance and time. **[Nov/Dec 2018] [D]**

5. Explain the formation of energy bands in various materials[refer review of solid state physics topic**][Nov/dec 2016] [D]**

6. Derive an expression for the product[np] for a degenerate n type semiconductor**[Apr/May 2017] [D]**

7.Derive the expression for concentration of electrons and holes in an intrinsic semiconductor with relevant diagrams**[Apr/May 2013] [Apr/May 2019] [D]**

8. What is diffraction and explain its types with suitable diagrams**[Apr/May 2019] [D]**

UNIT - II

DISPLAY DEVICES AND LASERS

1. What do you meant by display devices?[D]

Display device is an output device for presenting information in visual form. When the input information is supplied with an electrical signal, then that display device is called an electronic display device. There are two categories of display device. Display device that emit their own radiation or active devices and display device that modulate the incident radiation to provide display information.

2. What are the different luminescent processes?[D]

The different luminescent processes are

1.Electroluminescent processes

2.Cathodoluminescent processes

3.Photoluminescent processes

4.Injection luminescent processes

3. Define the different types of luminescent processes[D].

Electroluminescent processes are luminescent process in which excitation results from the application of electric field. In cathodoluminescent process, excitation occurs due to the bombardment with beam of electrons. In photoluminescent processes, excitation occurs from the absorption of photons. In injection luminescent processes, excitation occurs by electron-hole recombination by crossing the pn junction diode.

24. Name the different types of display devices.[D]

Different types of display devices are

Plasma devices

Numeric display devices

- LED
- LCD
- Lasers

5. What are plasma devices?[D]

Plasma devices are display devices in which, emission of light takes place when an electric current is passed through a gas. Free electrons are present in the gas. When an electric current is passed these free electrons acquire high kinetic energy and collide with the atoms in gas. This lead to energy level greater than the ground level. After that, it will again loose energy and reaches in the ground state by emitting light.

6. Discuss briefly about LCD. [D]

This is one of the most common passive display device. LCD consumes least power compared to all other display devices. There are two types of LCDs namely, reflective LCD and transmissive LCD. Reflective LCD requires front end illumination and transmissive LCD requires rear end illumination.

7. What are the two types of LCD and compare both?[D]

The two types of LCDs are reflective LCD and transmissive LCD. Comparisons between the two are,

Reflective LCD	Transmissive LCD
1. It requires front end illumination	1. It requires rear end illumination

8. What do you meant by nematic ordering and cholesteric ordering?[D]

In nematic ordering, the molecules are aligned parallel to each other. The molecules are free to move each other with the properties of liquid. It consists of two benzene rings linked with a central group. Eg: 4-methoxybenzylidine-4-butylanaline.

In cholesteric ordering, materials are made up of large number of planes having nematic structure. In this type, the ordering changes from one below the other. Distance between planes of same orientation are referred to as pitch.

9. Mention some important LED materials.[D]

- Gallium Arsenide(GaAs)
- Gallium Phosphide(GaP)
- Gallium Arsenide Phosphide($GaAs_{1-x}P_x$)
- Gallium Aluminum Arsenide($Ga_xAl_{1-x}As$)

10. What are the two common electroluminescent devices?[D]

- A.c. powder display

- D.c power display

11. What are numeric display devices? [D]

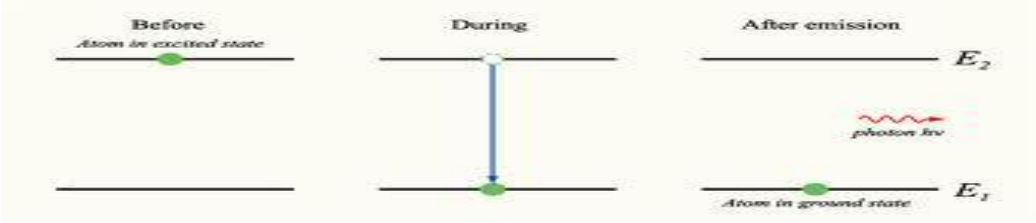
This is also a type of optical display device. Numerical displays are used for conveying more information compared to other display devices. It is a simplest display format used to form the numbers from 0 to 9. It consists of seven bar segments. Each bar consists of several discrete display elements depending on size. More complex characters can be obtained using 7 x 5 matrix. This type consists of 7 rows and 5 columns. In LED, if we are using numerical display of this type, these 35 elements will be grown to a single substrate. Here each bars consists of 35 discrete elements. All the characters are less than 5mm.

12. What do you meant by laser? [D]

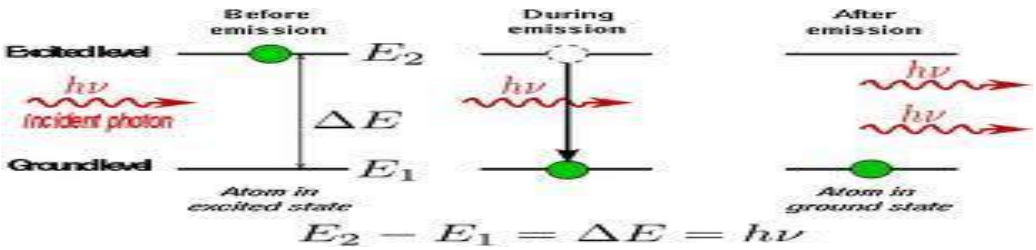
A laser is a device that emits light (electromagnetic radiation) through a process of optical amplification based on the stimulated emission of photons. The term "laser" originated as an acronym for Light Amplification by Stimulated Emission of Radiation. The emitted laserlight is notable for its high degree of spatial and temporal coherence, unattainable using other technologies.

13. What do you meant by spontaneous emission and stimulated emission? [Apr/May 20196 [D]

In spontaneous emission process, electron drops to the lower level in an entirely random way and stimulated emission process in which electron is triggered to undergo the transition in presence of photons of energy E_2-E_1. Under normal conditions we will see only spontaneous emission.



Stimulated emission is the process by which an atomic electron (or an excited molecular state) interacting with an electromagnetic wave of a certain frequency may drop to a lower energy level, transferring its energy to that field. A photon created in this manner has the same phase, frequency, polarization, and direction of travel as the photons of the incident wave.



14. What is meant by population inversion and how it is achieved in laser medium? [Apr/May 2016] [D]

Population inversion occurs when a system such as a group of atoms or molecules exists in state with more members in an excited state than in lower energy states. The concept is of fundamental importance in laser science because the production of a population inversion is a necessary step in the workings of a standard laser.

15. What is meant by optical pumping in lasers? [D]

Optical pumping is a process in which light is used to raise (or "pump") electrons from a lower energy level in an atom or molecule to a higher one. It is commonly used in laser construction, to pump the active laser medium so as to achieve population inversion.

16. Discuss about the threshold conditions in laser. [Apr/May 2017] [D]

The major threshold conditions in laser are,

- A steady state level of oscillation should be reached when rate of amplification is balanced by rate of loss in continuous laser.
- Population inversion is a necessary condition in pulse laser.
- The gain coefficient must be large enough to overcome losses and oscillations.

17. What are major causes of losses in laser? [Nov/Dec 2017] [D]

- Transmission at the mirrors
- Absorption and scattering at the mirrors
- Absorption in the laser medium
- Scattering at laser medium
- Diffraction losses at the mirrors

18. What do you meant by mode locking?[D]

Mode locking is a technique for producing periodic, high power, short duration laser pulses. Normally laser cavity supports many modes simultaneously. In such lasers output depends on phases, frequencies, and amplitude of the nodes.

19. Mention the different classes of laser.[D]

The different classes of laser are,

- Doped insulator laser
- Semiconductor lasers
- Gas lasers
- Dye lasers

20. State Heisenberg's uncertainty principle[Apr/May 2018] [D]

In quantum mechanics, the Heisenberg uncertainty principle states a fundamental limit on the accuracy with which certain pairs of physical properties of a particle, such as position and momentum, can be simultaneously known. The uncertainty principle was a monumental discovery in the early development of quantum theory. It implies that it is impossible to simultaneously measure the present position while also determining the future motion of a particle or of any system small enough to require quantum mechanical treatment.

21.What is meant by modulation bandwidth of LED[Apr/May 2018] [D]

It is defined as the high frequency at which the efficiency has fallen by 3db

BW=0.35/tr

$=1/\tau$

22.What is Frank Keldysh effect? [Nov/Dec 2018] [D]

Frank Keldysh effect ia a change in optical absorption by a semiconductor when an electric field is applied.

23.Find the Q-factor of a laser cavity oscillating at 650 nm and having a line width of 1mhz

Q= resonant frequency/line width[Apr/May 2019] [D]

$=V/\Delta V$ =1 mhz/650 nm

24. Why cathode lumini is less efficient then photolumine? [Apr/May 2019] [D]

When electrons have less energy than this value and E_c they can lose energy by exciting lattice vibrations. Energy may be wasted in photon generation. For a range of semiconductor materials that the total number of electron hole pair generated may be given as

$$E_g/(\beta E_g)$$

PART B

1.Explain the mechanism of electro luminescence with neat diagram and also explain about operation of ac electroluminescence device. [**NOV/DEC 2013 ,NOV/DEC2016] [D]**

2.Explain the construction and operation of LCD [MAY/JUNE 2013] **[D]**

3.Discuss the theory of population inversion and threshold condition in two layer laser system and also explain the various transition involved in a four level system Population inversion **[MAY/JUNE 2013] [NOV DEC 2016] [APR/MAY 2017] [D]**

4.Describe the concept of producing high power short duration pulses from laser.What are the various methods to accomplish this? Explain them **[NOV/DEC 2013] [D]**
Explain Mode locking of laser

5.Explain the operation of LED and also derive an expression for the frequency response and modulation bandwidth of an LED **[APR/MAY 2017] [D]**

6.Derive the operation of semiconductor laser in detail**[Nov/Dec 2015] [D]**

7.Draw the common cathode LED seven segment display and explain its working**[Nov/Dec 2015] [D]**

8.What is luminescence and explain all its types with relevant diagrams**[Apr/May 2018][D]**

9. Discuss the theory of laser emission and population inversion**[Nov/Dec 2016] [Apr/May 2019] [D]**

10. Discuss the application of lasers**[Apr/May 2019] [D]**

11. Derive the expression for the total photon flux emitted by a LED due to forward bias injection**[Apr/may 2017] [D]**

12. Derive the gain in a semi conducting device**[Apr/may 2017] [D]**

UNIT - III

OPTICAL DETECTION DEVICES

1. **Explain thermal detectors. [D]**

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.

2. **What is the internal quantum efficiency of photodetector? [D]**

Quantum 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.

$$\eta = \frac{\text{Number of corresponding electrons in the external circuit}}{\text{Number of incident photons}}$$

3. **Explain photoconductors. [D]**

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 are collected at opposite end and results in photocurrent.

4. **What do you mean by Kerr effect?[Apr/May 2015] [D]**

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.

5. **Name the different types of thermal detectors?[D]**

The different types of thermal detectors are,

- Thermoelectric detectors
- Bolometer
- Pneumatic detectors
- Pyroelectric detectors

6. Define photodetectors. [D]

Photodetector is an optoelectronic device that absorbs optical energy and converts it into electrical energy that produces photocurrent. Photodetectors are used to detect optical signal ranging over a very wide range of optical spectrum.

7. What are the different types of photodetectors? [D]

The different types of photodetectors are,

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

8. What are the two types of photoconductors? [D]

The two types of photoconductors are a.c. photoconductors and d.c. photoconductors.

9. What are the factors that limit the response time of photodiodes? [D]

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

10. Define responsivity. [D]

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

Responsivity =Number of corresponding electrons in the external circuit

11.Define noise equivalent power[D]

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 $A^{1/2}$. 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

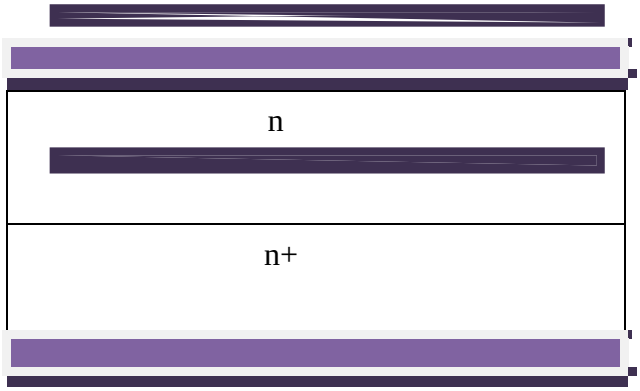
$$D^* = (A\Delta f)^{1/2}/NEP$$

12. Discuss briefly about pin photodiode. [D]

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.

13. How Schottky photodiodes are made? [Nov/Dec 2016] [D]

In Schottky photodiode, a thin metal coating is applied to an n-type silicon substrate. When an electron-hole pair is generated within the depletion region, the electron and hole will be separated by the action of internal field.



14. Define Pockels effect.[Apr/May 2016] [D]

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 niobate or gallium arsenide and in other noncentro- symmetric media such as electric-field poled polymers or glasses.

15. What is a bolometer? [D]

Bolometer is a thermal detector. The structure of bolometer is similar to wheatstone bridge. In this, a sensing element is placed instead of one of the resistor. This sensing element will absorb the incident radiation.

16. What is the working principle of thermal detectors? [D]

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.

17.What do you meant by a photodiode? [D]

A photodiode is a type of photodetector capable of converting light into either current or voltage, depending upon the mode of operation. The common, traditional solar cell used to generate electric solar power is a large area photodiode. Photodiodes are similar to regular semiconductor diodes except that they may be either exposed or packaged with a window or optical fiber connection to allow light to reach the sensitive part of the device.

18. Define signal to noise ratio in photoconductors. [D]

It is defined as the ration of conductivity of thermal noise to conductivity of dark current.

$$SNR = (conductivity)_{light}/(conductivity)_{dark}$$

19. How is a photodiode designed and why it is designed so? [D]

A photodiode is designed to operate in reverse bias condition. If an electron-hole pair is generated by photon absorption in this junction, the internal field will cause electron and hole to seprate.

20. What are the various processing steps taking place inside a photodetector?[Nov/Dec 2017] [D]

There are three steps involved in photodetector process and they are,

- Absorption of optical energy and generation of carriers
- Transportation of photo generated carrier with or without gain
- Carrier collection and generation of photocurrent that flows through external circuit

21. What is a bolometer[D]

Bolometer is a thermal detector. The structure of the bolometer is similar to a wheat stone bridge. In this a sensing element is placed instead of a resistor.

22.What are the various methods involved in the charge separation of photo diode[Apr/May 2018] [D]

1. Photo voltaic mode of operation

2. Photo conductive mode of operation.

23. Write any two example of magneto optic devices[Nov/Dec 2018] [D]

CD writer

Flash memory devices

MO-USB

24. What are the advantages of photoconductive detectors? [Apr/May 2019] [D]

1. Increase in the conductivity of the semiconductor

25. Limitations of germanium based photo diode[Apr/May 2019] [D]

They generate more noise than silicon due to their greater band gap

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][D]**

2.Explain the principle, construction and working of pyro-electric detector**. [Nov/Dec2016] [Apr/May 2018] [D]**

3. Explain the principle and operation of photo transistors**[Apr/May 2018] [D]**

4. With an equivalent circuit, explain the factors affecting the bandwidth of a PIN photodiode. **[May/June-2013, Apr/May 2017][D]**

5. Discuss the various parameter used to access the performance cof detectors[**Nov/dec 2016] [D]**

6.Derive can expression for the gain of photoconductor with dc excitation at different levels of increasing applied bias if the device has one ohmic contact for electron flow and the other blocking holes**[Nov/dec 2016] [D]**

7.Brief about the various noise sources in a photo multiplier tube**[Apr/May 2019] [D]**

8.Explian about silicon and avalanche photo diode**[Apr/May 2019] [D]**

9.Explain about Pneumatic detector**[D]**

10.Explain about bolometer. **[D]**

UNIT – IV

OPTOELECTRONIC MODULATOR

Part-A

1. Compare analog and digital modulation.[D]

Analog Modulation	Digital Modulation
1. Both message and carrier waves are continuous.	1. Message signal will be in continuous form and carrier will be digital
2. Requires higher SNR	2. Requires low SNR
3. Good for only low frequency and low bandwidth signals.	3. Good for high frequency and high bandwidth signals.
4. High current levels are needed for modulating higher bandwidth signals.	4. Lower current levels is needed for modulating higher bandwidth signals

2. Define electro-optic modulators and electro-optic effect. [D]

Electro-optic modulators is an optical device in which a signal controlling element displays electro-optic effect to modulate a beam of light. The modulation can be done by changing phase, frequency, amplitude, or polarization of the modulated beam. Electro-optic effect refers to change in refractive index of the material resulting from application of a d.c. or low frequency electric field.

3. Define the term birefringence. [D]

Birefringence refers, for a linearly polarized wave that is propagating in z-direction, itspolarization vector will depend on the direction of electric field. Due to this effect, the amplification of electric field in one direction will not be same in opposite direction.

4. Mention the advantages of high bandwidth. [D]

The main advantages of using high bandwidth is we can able to modulate higher frequency signals with low SNR. Also, current needed is very low

5. What are magneto-optic devices? [APR/MAY 2017][D]

These are devices which work under magneto-optic effect. A magneto-optic effect is a phenomena in which an electromagnetic wave propagates through a medium that has been altered by the presence of a

quasistatic magnetic field. In such a material, which is also called gyrotropic or gyromagnetic, left- and right-rotating elliptical polarizations can propagate at different speeds, leading to a number of important phenomena

6 . What are acoustoptic devices? [D]

Acoustoptic devices are devices which work under acoustoptic effect. Acoustoptic effect refers to there will be a change in material permittivity ‘e’ due to mechanical strain ‘a’.

7. What do you mean by SEED? [D]

This is a device exhibiting nonlinear absorption or reflection of an optical signal, photonic switching, bistability, and optically induced oscillations. It is a combination of a detector self biasing a n electro-absorption modulator. The working is based upon multiple quantum well (MQW)-III V technology.

8. What are acoustoptic modulators? [D]

These devices will vary the acoustic wave properties such as amplitude, phase, frequency, or polarization to modulate acoustic wave. These properties can be varied by making the optical wave travelled through acoustic field.

9. What are the limitations of acoustoptic modulators? [D]

The limitations of acoustoptic modulators are,
 The design is complex and should be carefully designed
 Switching speed is limited
 Light cannot be fully switched ON and OFF

10. Define acoustoptic filter. [D]

The principle of operation of acoustoptic filter is based upon the wavelength of diffracted light. Wavelength depends on frequency. By tuning the frequency of acoustic wave, desired wavelength of optical wave can be diffracted.

.

11. Name the different types of electro-optic modulators. [D]

The different types of modulators are,

- Electro-optic amplitude modulation
- Quantum well modulators
- BRAQWET modulators

12. What are the drawbacks of analog modulation? [D]

- requires high SNR
- for large bandwidth, higher amount of current is needed
- suitable only for low frequency signal modulation

13. What are the different types of SEED? [D]

The different types of SEED are,

- R-SEED or Resistor Loaded SEED Function
- D- SEED- S- SEED
- L-SEED

14. Why we go for bipolar controller modulator?[D]

In SEED, the path and effects of the signal and control beam are same. So, it is difficult to distinguish between the two. Also it does not have any gain. To achieve larger tolerance gain is very sufficient. So we go for bipolar controller modulator.

15. What are the advantages of bipolar controller modulator?[D]

- High gain
- Large uniform electric field

16. Mention the types of acoustoptic filter.[D]

The types of acoustoptic filter are,

- Collinear filters
- Noncollinear filters

17. Define collinear filter and non-collinear filter[D]

Collinear filters does not need to be polarized for modulating the optical wave. Non-collinear filters has to be polarized for modulating.

18. What are acoustoptic deflectors? [D]

Acoustoptic deflectors spatially controls the optical beam. In the operation, power of the transducer is kept at a constant level, while the acoustic wave frequency is varied to deflect the optical beam in different angular positions.

19. Mention the categories of acoustoptic devices. [Apr/May 2018] [D]

The categories of acoustoptic devices are

- Acoustoptic modulator
- Acoustoptic filter
- Acoustoptic defelctors

20.Define bragg cell[Nov/Dec 2017] [D]

An acoustic modulator also called a bragg cell,uses the acoustic optic effect to diffract and shift the frequency of light using sound waves.

21.What is the principle of quantum confined stark effect(QCSE) based optical modulation. [Apr/May 2019] [D]

In quantum well heterostructure ther will be a strong interaction of the electric field with the optical wave. The absorption in the subband transition energy is dominated by the excitonic effect and the electro absorbtion is greatly enhanced. This is known as QCSE.

PART B

1.Explain the concept of external modulation and compare with direct modulation. **[Apr/May 2019] [D]**

2. Briefly explain about the Analog and Digital Modulation**[Apr/May 2018] [D]**

3.Explain the concept of birefringence in Uniaxial crystal with necessary diagrams.
[May/June-2013] [D]

4. Explain with neat diagram, the construction of electro optic effect based external modulator. Also deduce the expression of modulated light. **[Nov/Dec - 2015] [D]**

5. Discuss in detail the principle and operation of a photonic switch based on self electro optic Device (SEED**). [Nov/Dec - 2015] [D]**

6. Explain the concept of Bipolar controller Modulator. **[Nov/Dec - 2015] [D]**

7. Explain the Electro-Optic Modulator [**NOV/DEC2016, APR/MAY 2017][D]**
1. BIREFRINGENCE AND THE ELECTRO-OPTIC EFFECT:
APPLICATION TO PHASE MODULATION

8. Explain the Magneto-Optic Devices**[Apr/May 2019] [D]**

9.Explain about Acoustic optic effect: **[Nov/Dec 2013] [D]**

UNIT V

OPTOELECTRONIC INTEGRATED CIRCUITS

PART A

1. What are optoelectronic integrated circuits? [D]

Optoelectronic integrated circuits refers to the integration of electric and optical components and optical interconnection. Optoelectronic devices makes electrons and photons to perform single function. These devices are capable of converting optical to electric form and vice versa.

2. What are active guided wave devices and give examples? [D]

Active guided wave devices refers to the active components present in the guided wave. These devices can be integrated with OEIC with active optoelectronic devices.

3. Mention the applications of optoelectronic integrated circuits[D]

 It is applicable in the field of telecommunication and radar applications.

4. List out the advantages of optoelectronic integrated circuits. [Nov/Dec 2016] [D]

 Low cost
 Large scale integration
 Photonic devices and circuits can serve unique functions
 New functional capabilities can be emerge by integrating electronic and photonic devices and circuits

5. What are the disadvantages of hybrid integration? [D]

 Design is complex
 Damage in any of the device will affect the entire working

6. Distinguish between hybrid and monolithic integration. [D]

Hybrid Integration	Monolithic Integration
1. As the name suggests discrete devices on separate functional block or chips are connected using electronic or optical interconnections 2. No planarity 3. Complex design	1.In monolithic integration all active and passive components are fabricated on the same chip. 2. Planarity is high 3. Less complex

7. Define waveguide. **[D]**

A waveguide is a dielectric region through which light is propagated. These regions were also surrounded by dielectric regions or air having smaller dielectric medium.

8. Mention the types of waveguides. [D]

The different types of waveguide are,
 Ridge waveguide
 Buried channel waveguide
 Strip-loaded waveguide

9. Explain briefly about directional coupler. [D]

This is simplest coupler formed by the integration of optical circuit. This is useful in transferring energy from one waveguide to another. It consists of 2 parallel waveguides. Transfer of optical energy takes place between these 2 waveguides.

10. What is the objective of OEIC? [Apr/May 2017] [D]

The objective of OEICs is to bring fiber systems to home and individual subscribers in the form of telephone links and broadcast cable TV. In order to extend optoelectronic technologies to subscriber, the systems need the development of lasers with precise frequency control and tenability and wavelength-selective detectors and receivers. Datatransmission rates of several tens of gigabits/sec will be attained by these circuits and systems.

11. How guided waves can be formed? [D]

Guided wave devices are used for routing optical signal on a chip and also for make it perform the functions of directional coupling, filtering, and modulation. Simplest method for forming guided waves is by introducing free carriers in the semiconductor material. This will reduce the refractive index of the material.

12. Mention the types of integrated transmitters. [D]

Optoelectronic integrated transmitters can use either laser or LED as transmitting devices.

13. Mention the types of integrated receivers

- Front-end photoreceivers
    - MODFET

14. What do you meant by front-end photoreceivers? [D]

The basic purpose of detector is to detect the incident light and convert it into an electrical signal containing the information on the light at transmitting end. The important performance characteristics of photoreceiver are operating bandwidth and sensitivity. Sensitivity plays a vital role in deciding the number of repeaters needed in a long haul communication system. The receiver sensitivity is defined as the minimum amount of optical power level needed at the receiver input so that the signal-to-noise ratio is greater than a given value.

15.What do you meant by MODFET?[D]

MODFET refers to modulation doped field effect transistor. MODFET can be regrown with help of monolithic integration of $In_{0.53}Ga_{0.47}As$ photodiode with $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ modulation doped FET by regrowth on InP. The MODFET consists of a layer of undoped low-bandgap material forming a heterojunction with a highly doped high-bandgap material. Due to the electron affinities of the two layers, electrons are transferred from the high- bandgap material to low-bandgap material to form a two dimensional electron gas.

16. Write briefly about hybrid integration. [D]

In this type of integration, as the name suggests discrete devices on separate functional block or chips are connected using electronic or optical interconnections. An example for this type of integration is junction laser with its driver circuit consisting of bipolar transistor to form a transmitter. Advantage of this type hybrid integration is the possibility of using high performance discrete devices as components. The disadvantages are lack of compactness and enhanced parasitic effects in terms of interconnects bonding and lead wires.

17Write briefly about monolithic integration[Apr/May 2018] [D]

In monolithic integration all active and passive components are fabricated on the same chip. Unlike silicon ICs almost all parts are made with the same material and same processing steps. Monolithic integration can be achieved in either vertical or horizontal configuration. In the vertical scheme, electronic and optical structures are epitaxially grown sequentially with an isolation layer in between.

18.What are the disadvantages of hybrid integration?[D]

- Design is complex
- Damage in any of the device will affect the entire working

19. How can we achieve monolithic integration? [D]

Monolithic integration can be achieved using two schemes namely vertical scheme and horizontal scheme.

20. What is the disadvantage of vertical monolithic integration? [D]

The disadvantage of vertical monolithic integration scheme is it cks planarity.

21. What is the advantages and disadvantages of horizontal scheme? [D]

Advantages	Disadvantages

1. It achieves planarity 2. We can regrow the selective area	1. During the regrowing process, that place can have large density of traps and other electrically active defects that can affect the performance of regrown area.

22. What is plasma etching? [Apr/May 2018] [D]

It is a form of plasma processing used to fabricate IC. It involves high speed stream of glow discharge of an appropriate gas mixture being shot at a sample. During the process the plasma will generate volatile etch products at room temperature from the chemical reaction between the elements of the material etched and the respective species generated by the plasma.

23. What are the different types of optical interconnects? [Apr/May 2019] [D]

- Optical switches
- Crossbar switches
- Optical routers

24. Define eye closure[Apr/May 2019] [D]

Eye pattern can be used to find the sampled digital signal pattern. The inter symbol interference and additive noise appears as eye closure.

25. Give the condition for complex power transfer from one guide to another in directional coupler[Nov/dec 2018] [D]

The guide wave integrated optical circuit element called directional coupler. Directional coupler is used for transferring optical energy from one waveguide to another.

It consists of two parallel waveguides between which the transfer of optical energy occurs due to overlapping of waveguides.

PART B

1. i) Explain any two applications of OEIC in detail. **[May/June-2013] [Nov/Dec 2016] [D]**

2. ii) Write a note on Monolithic and hybrid integration OEIC fabrication.
(or) **[May/June-2013] [D]**
Explain the importance of Optoelectronic Integration [**Nov/Dec-2013] [D]**

3. Draw the diagram of a PIN diode and HBT integrated front end photo receiver and explain its operation. **[May/June-2013] [D]**

4. Discuss the noise performance in Integrated photo receivers. **[May/June-2013] [D]**

5.Photoreceiver bandwidth considerations

6. Describe the fabrication process of an opto electronic integrated transmitter circuit by molecular beam epitaxy regrowth. **[May/June 2012] [Nov/dec 2018] [D]**

7. Explain the principles and operation of **[Nov/Dec-2013] [NOV/DEC 2016] [D]**

i) Waveguide Coupler
ii) Waveguide interferometer
iii) Active directional coupler switch

8. Active guided wave devices
(or)
Describe about the guided wave Mach-Zehnder interferometer. **[Nov/dec 2018] [D]**

9. What is the need for intergration of OED and draw the block diagrams of essential elements in OEIC**[Nov/dec 2016] [D]**

10. Explain the principle and operation of waveguide and coupler in details**[Nov/dec 2016]** [**Apr/May 2019] [D]**

11. What is molecular beam epitaxy? Explain[**Apr/May 2019] [D]**