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Model Answer

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Sets (I) / (II)

Q-1 (i) (a) (a) — 1
(ii) (b) (b) — 2
(iii) (c) (c) — 3
(iv) (a) (d) — 1
(v) (a) (e) — 1
(vi) (a) (f) — 1
(vii) (b) (g) — 2
(viii) (d) (h) — 4
(ix) (b) (i) — 2
(x) (b) (j) — 2

Q-2 (i) Advantages of optical fiber communication

(a) Transmission loss is low.

(b) Optical fiber cable is lighter and thinner than other cables.

(c) There is complete electrical isolation between transmitter and receiver because signal is propagating in the form of light waves.

(d) Information carried by fiber cable is more than other cables

(e) Information carried by fiber cable is less affected by noise.

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Q-2(ii) In Phase Modulation, phase angle of carrier signal is varied in accordance with instantaneous value of a message signal.

Let $x(t)$ = message signal

$c(t)$ = carrier signal = $A\cos(\omega_c t)$

Here, A = amplitude of $c(t)$, ω_c = angular frequency of $c(t)$.

ϕ = phase angle of unmodulated carrier signal = $\omega_c t$

According to Phase Modulation, this phase angle 'ϕ' is varied linearly with a message signal.

Let instantaneous value of phase angle is ϕ_i

$\therefore \phi_i = \omega_c t + K_p \cdot x(t)$

Here K_p = phase sensitivity

Now, phase modulation wave is expressed as

$$s(t) = A\cos\phi_i$$

or, $$s(t) = A\cos[\omega_c t + K_p \cdot x(t)]$$

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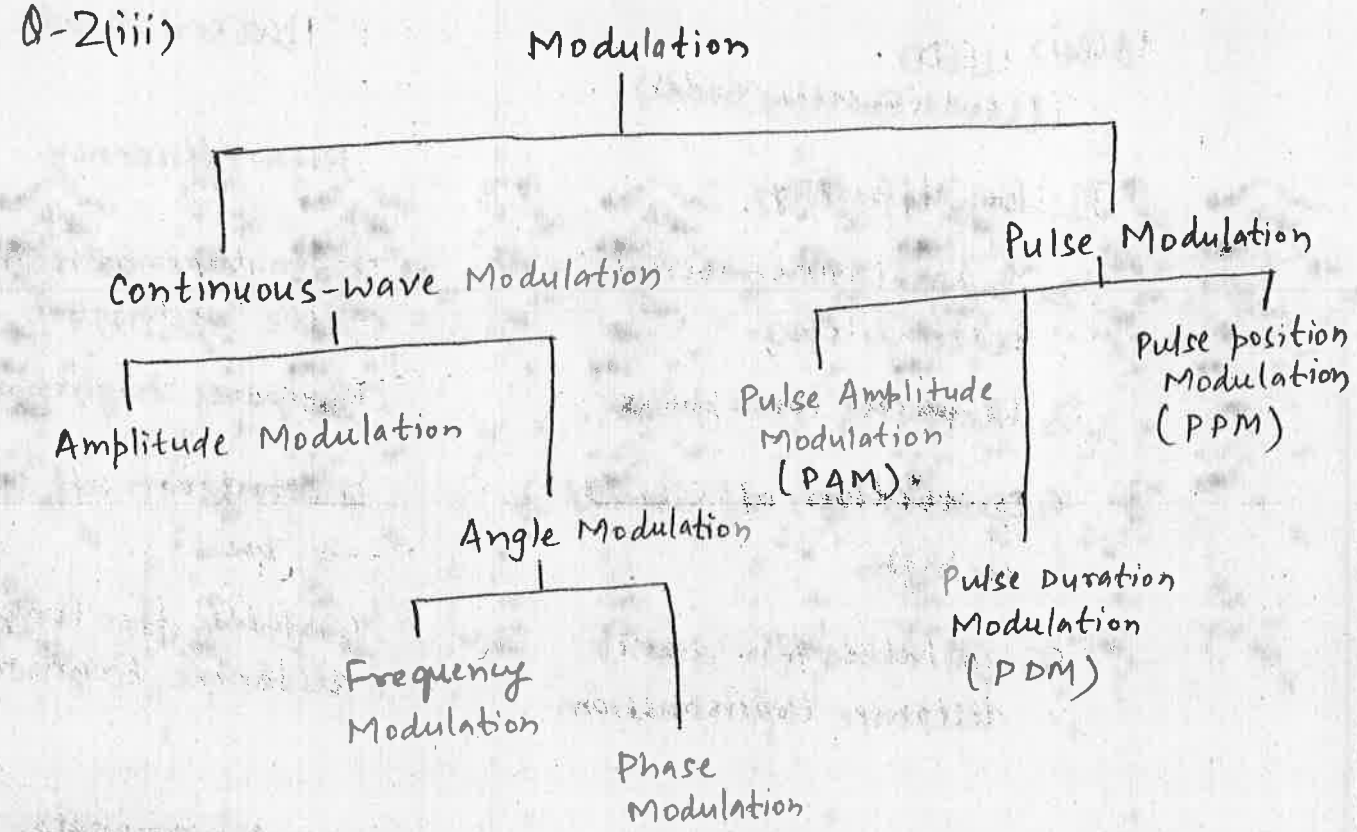
Q-2(iii)



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Q-3(i)

LED (Light Emitting Diode)	Laser Diode
1. Low efficiency	High efficeency
2. Data transmission rate is low	Data transmission rate is high.
3. Requires low power	Requires high power
4. Distortion of signal is high	Distortion of signal is low.
5. Suitable for short distance transmission	Suitable for long distance transmission.

Q-3(ii) (a) frequency of message signal = 2000 Hz

(b) frequency of carrier signal = 10^5 Hz

(c) modulation index of amplitude modulated wave

$$= \frac{\text{maximum amplitude of message sign}}{\text{maximum amplitude of carrier sign}}$$

$$= \frac{6}{12} = \frac{1}{2} = 0.5$$

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Q-3(iii) We use ~~ciryal~~ single mode ~~step~~ index fiber for long distance communication due to following reasons —

(a) Low attenuation of signal due to smaller core diameter.

(b) It offers higher bandwidth. It means more data or information can be sent.

(c) It offers very low dispersion.

Q-4. There are two types of optical fiber.

1. Step-index fiber → In step-index fiber, density of core remains constant from center to edges of core. Due to constant density of core, a light beam from sender moves in a straight line through this core until it reaches the interface of core and cladding. Density of core is higher than density of cladding. Due to sudden change in the density at the interface, light beam reflects back towards the core and after several reflections, the light beam reaches its den destination. Due to sudden change in the density at the interface, the signal suffers from distortion.

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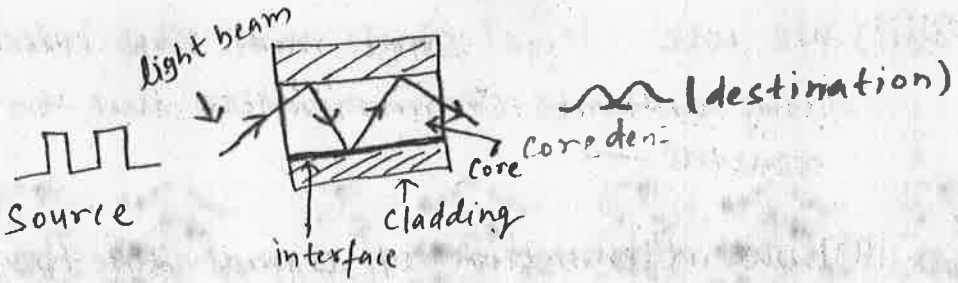
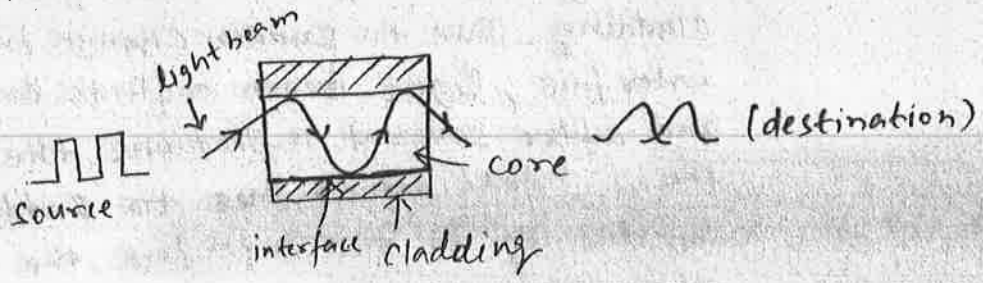


2. Graded-index fiber – In Graded-index fiber, density of core varies from center to edges. Density of core is highest at the center of the core and decreases gradually to its lowest at the edges. Due to gradual change in the density of the core, a light beam travels in a curved path through this core until it reaches the interface of core and cladding. At the interface, due to change in density, light-beam reflects back towards the core and after several reflection the light beam reaches its destination. ...
Due to gradual change in density, distortion of signal is less.



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Q-5. Multimode fiber.

Mutimode means multiple beams from a light source move through the core in different paths.

The movement of beams depends on the structurer of core.

In multimode fiber, different beams from a light source take different times to propagate through the core of fiber. This is known as intermodal dispersion.

Multimode uses both step-index fiber and graded-index fiber.

In multimode step-index fiber, the density of core remains constant from the center to the edges. A beam of light from sender moves in a straight line through this core. At the interface, due to the sudden change in density, light beam is reflected back and after several reflections it reaches its destination

In multimode graded-index fiber, the density of core varies from center to its edges. Beams of light from sender move through the core in curved paths.

Single-mode fiber

In single-mode a single highly focused light beam from a highly focused light source moves through the core.

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In single mode fiber, a single light beam propagates through the core. So, there is no intermodal dispersion.

Single mode fiber suffers from intramodal dispersion because spot size itself depends on the wavelengths.

Single mode uses step-index fiber. In single mode, diameter of step-index fiber is small compared to diameter of graded-index fiber.

Transverse cross-sections of different types of optical fiber

step-index multimode		Core diameter : 50 – 85 μm Cladding diameter : 125 μm
Graded-index multimode		Core diameter : 50 – 85 μm Cladding diameter : 125 μm
single mode step-index		Core diameter : 9 μm Cladding diameter : 125 μm

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Q-6. $n_{CO} = 1.5$

$n_{CL} = 1.2$

$n_o = 1$

Numerical Aperture $(N.A) = \sqrt{n_{CO}^2 - n_{CL}^2}$

$= \sqrt{1.5^2 - 1.2^2}$

$= \sqrt{2.25 - 1.44}$

$= \sqrt{0.81}$

$= 0.9$

Acceptance angle $= \sin^{-1}\left[\frac{\sqrt{n_{CO}^2 - n_{CL}^2}}{n_o}\right]$

$= \sin^{-1}\left[\frac{0.9}{1}\right]$

$= \sin^{-1}[0.9]$

$= 64.158^\circ$

Numerical aperture , can be defined as the ability of light gathering power of the fiber.

Acceptance angle is the maximum angle to the fiber at which the light beam should inter in order to propagate through the core.

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