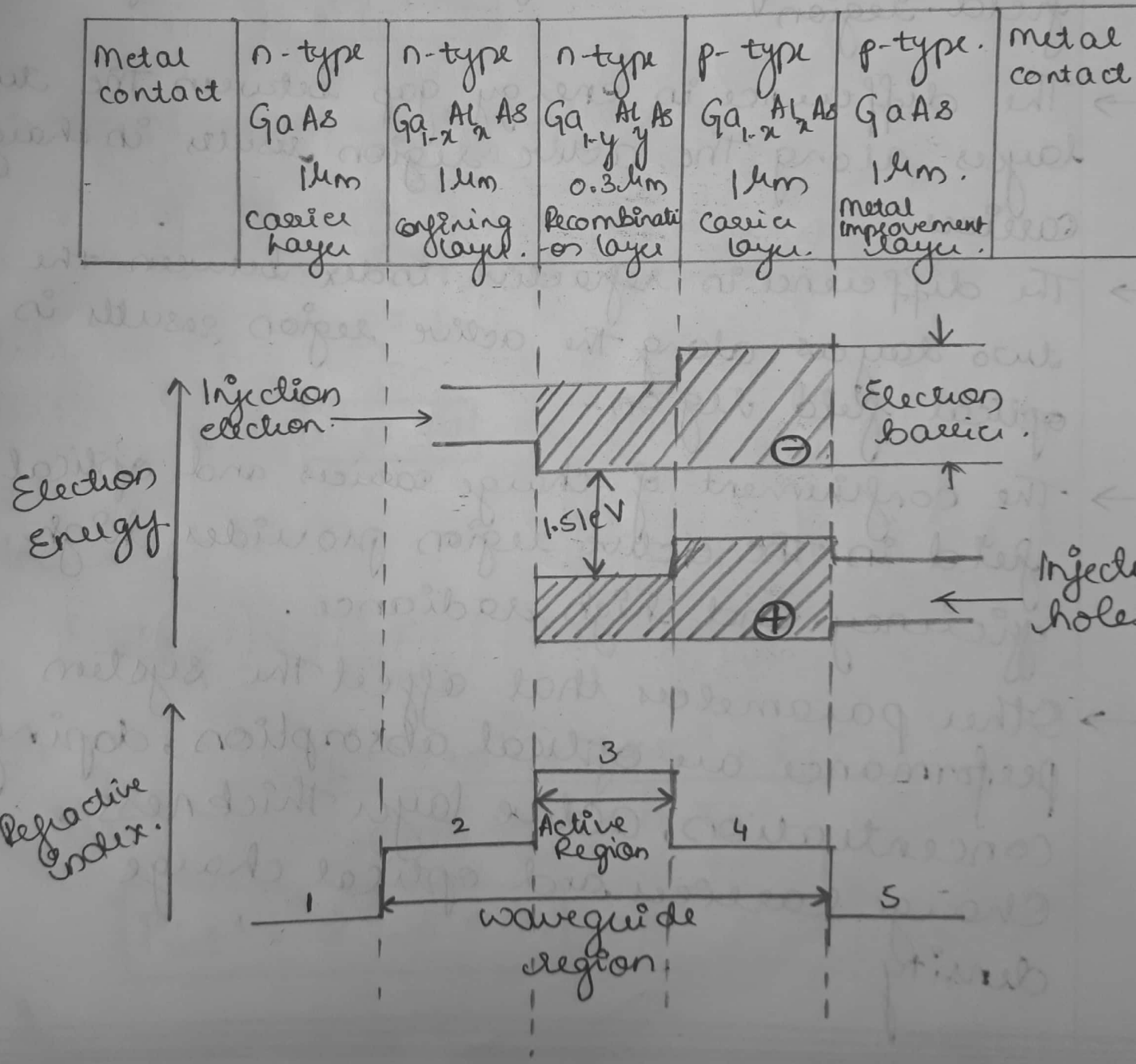
Internal Assessment Test II - April 2019.

1. Draw the cross section of GaALAs double hetero structu light emitti energy band gap diagram and refractive index variation. Explain the importance.



→ Double hetero structure is due to the differe
alloy layers along the active region.

→ GaAlAs structure came into study based on the
studies of laser diodes.

→ Since two alloy layers are along the active r
it confines of the charge carriers and optical
field region.

→ The difference is energy gap between the tw
layers along the active region results in charg
carriers

→ The difference is refractive index between the
two layers along the active region results in
optical field region.

→ The confinement of charge carriers and optical
field in the active region provides high
efficiency and high radiance.

→ Other parameters that affect the system
performance are optical absorption, doping
concentration, active layer thickness,
charge carriers and optical charge
density.

5.

Recombination bulk time

$$\tau = \frac{\tau_r \tau_{nr}}{\tau_r + \tau_{nr}}$$

$$= \frac{30 \times 100}{30 + 100}$$

$$= 27.1 \text{ ns}$$

Internal quantum efficiency

$$\eta_{int} = \frac{\tau}{\tau_r}$$

$$= \frac{27.1}{30}$$

$$= 0.77$$

Internal Power.

$$P_{int} = \frac{hcI}{\lambda \eta_{int}}$$

$$= \frac{6.625 \times 10^{-34} \times 3 \times 10^8 \times 0.040}{1310 \times 10^{-9} \times 0.77}$$

$$P_{int} = 29.2 \text{ mW}$$

CMR

6. Derive the expression for lasing condition and hence for optical gain in laser.

To determine lasing condition and resonant frequency we express electric field in electric phasor vector

$$E(z,t) = I(z)\, e^{-j(\omega t - \beta z)}$$

where $I(z) \longrightarrow$ Optical field Intensity

$\omega \longrightarrow$ Optical Radian frequency

$\beta \longrightarrow$ propogation constant.

Lasing is a condition when light amplif is possible in the diode. The requirem for lasing is that population inversion should take place.

$$I(z) = I(0) \exp\{[\Gamma g(h\nu) - \tilde{\alpha}(h\nu)]z\}$$

where $\tilde{\alpha} \longrightarrow$ effective absorption co-efficient

$\Gamma \longrightarrow$ optical fibre confinement factor.

When two materials with different refractive indices are used,

$$R = \left(\frac{n_1 - n_2}{n_1 + n_2}\right)^2.$$

Replace $z = 2L$

$$I(2L) = I(0)\, R_1 R_2 \exp\left\{\left[\left[g(n\nu) - \bar{\alpha}(n\nu)\right] 2L\right]\right\}$$

$$I(2L) = I(0)$$

$$e^{-j2\beta L} = 1.$$

Lasing occurs when $g \geq g_{th}$.

$$g_{th} = \bar{\alpha} = \alpha_{end} + \frac{1}{2L} \ln\left(\frac{1}{R_1 R_2}\right)$$

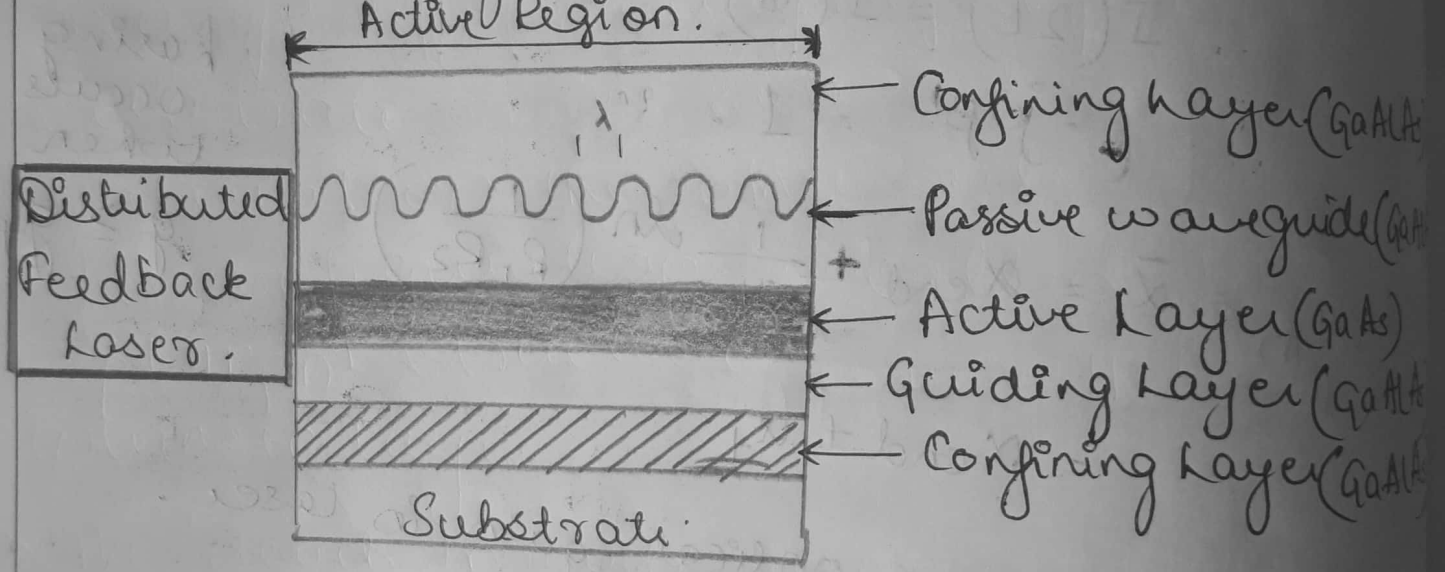
$$= \alpha_{end} + \alpha_t.$$

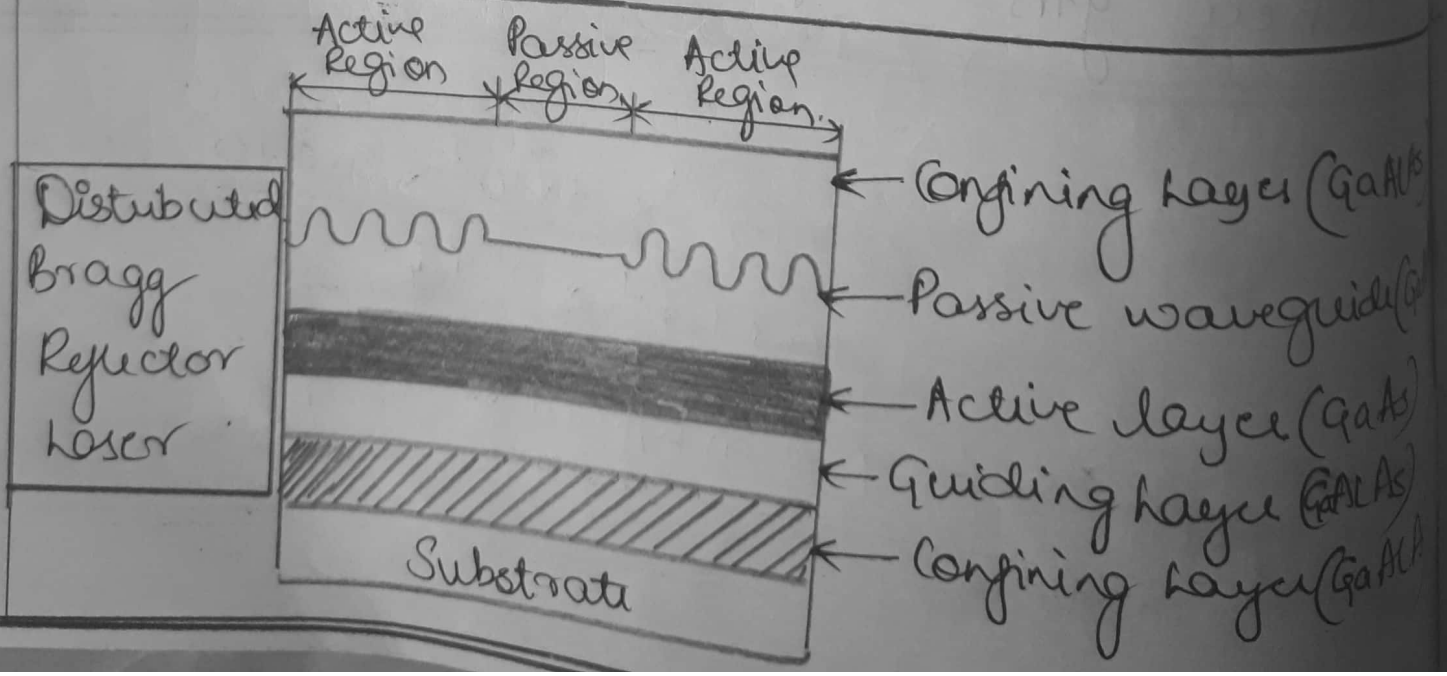
Where $g_{th} \rightarrow$ optical gain in laser.

7b. Types of laser with schematic diagram of any two laser types.

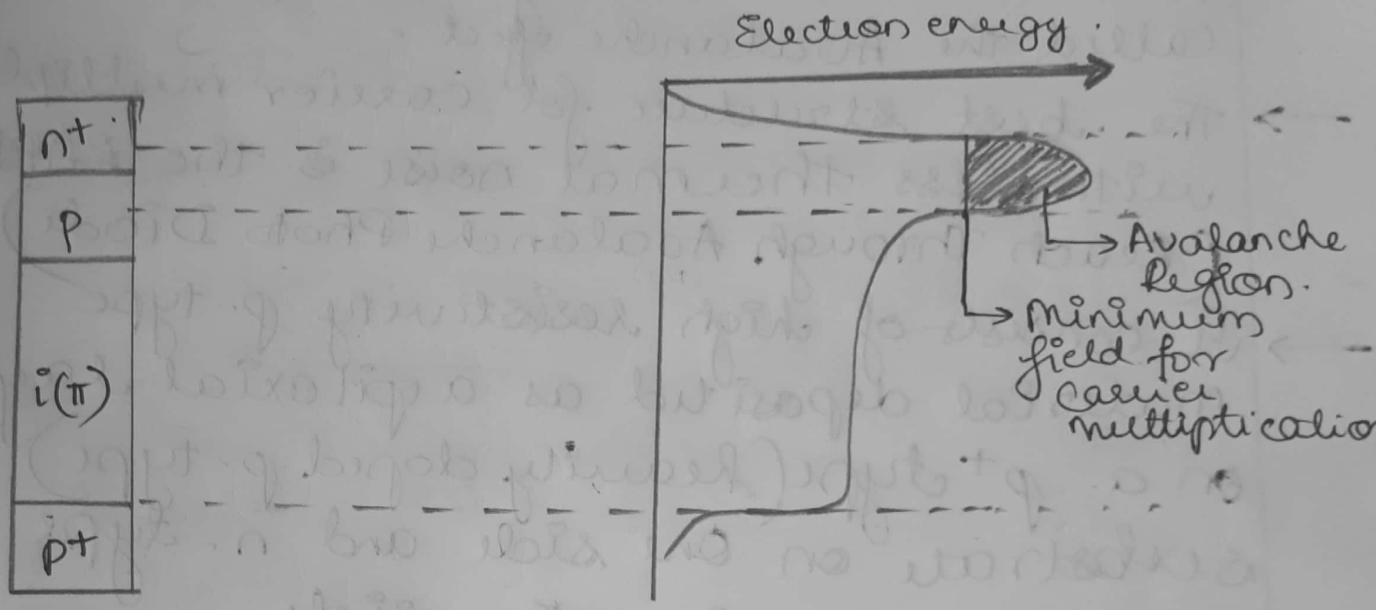
Types of LASER are.

→ Distributed Feedback Laser
→ Distributed Bragg Reflector Laser.
→ Distributed Reflector Laser.





(3b) With Proper sketch explain RAPD photodiode.



→ Avalanche photodiode internally multiply primary single photocurrent before the signal could enter the input of the following amplifier.

→ This increases the receiver sensitivity, as the photocurrent is multiplied before it is mixed with the thermal noise of the receive circuit.

→ In order for carrier multiplication to take place the charge carriers should pass through a high energy electric field where the carrier gains energy and move the bound electrons from valence band by colliding with them.

→ This condition is known as Ionization Impact of the charge carriers.

→ Before the diode breakdown voltage, there are finite number of charge carriers and

infinite number of charge carriers are the breakdown voltage. This phenomenon is called the Avalanche effect.

→ The best structure for carrier multiplication with less thermal noise is the RAPD (Reach Through Avalanche Photo Diode).

→ It consists of high resistivity p-type material deposited as a epitaxial layer on a p^+ type (heavily doped p-type) substrate on one side and n-type material on the other side.

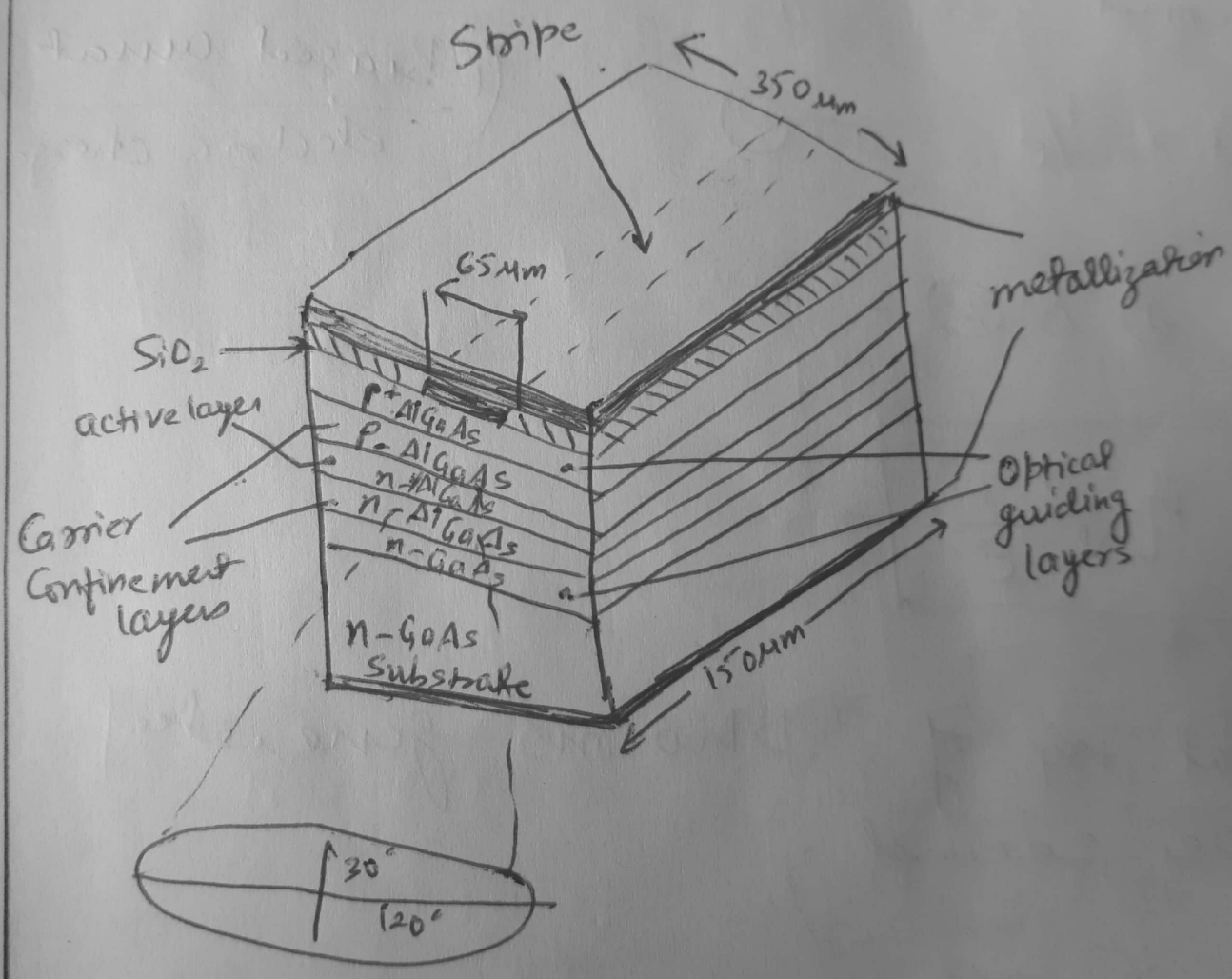
→ This configuration is called the $p^+ \pi p n^+$ structure where π is the intrinsic layer.

→ The 'reach-through' term is based on the photodiode operation where the depletion region increases and reaches through the semiconductor region.

3) a) Intramodal Dispersion :

- Pulse ~~brod~~ broadning in fibres results from the propogation delay between different m
- The output of the fibre depends on the transmission times of slowest and fastest modes.
- In single step fibre, there is no inter-modal dispersion.
- Intramodal dispersion can be reduced by adopting optimal refractive index.
- In multimode step index fibre, there is large propogation delay. It has large intramodal dispersion.
- In single step fibres, only intramodal dispersion occurs.
- The pulse broadning mainly depends on the delays than occur within an optical fibre cable.

4. Edge Emitter LED



7(a) Optical fiber Connector-

1. Low Coupling losses
2. Interchangeability
3. Ease of assembly
4. Low environmental sensitivity
5. Low cost and reliability
6. Ease of Connection