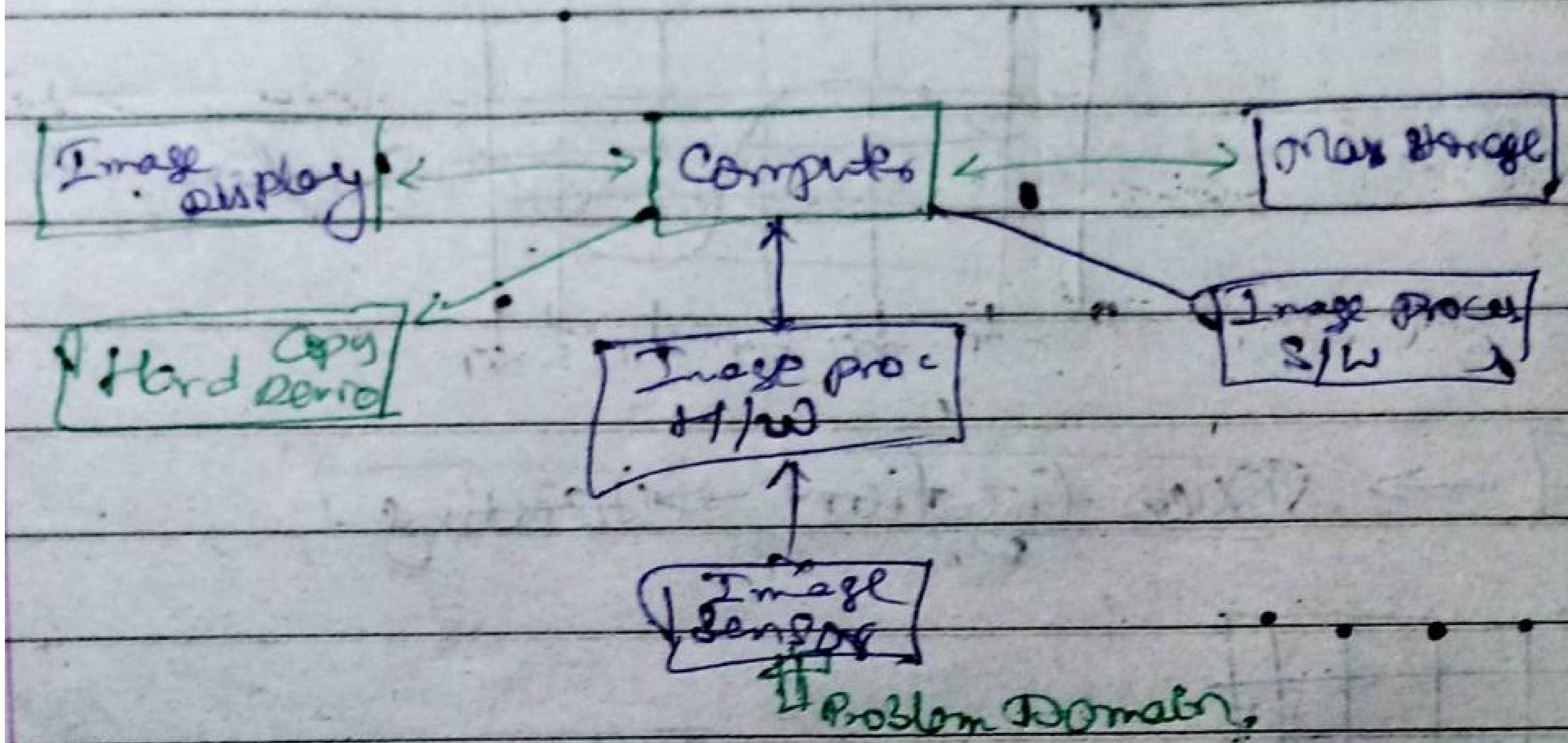
Head diagram Component of general purpose image p



(a) Concept of brightness adaption and discri-
nation in Image processing.

) Explain the smoothing of Images in freq
Domain using ideal, Butterworth & Gaussian
pass filter.

) (a) Explain the process of bright ness adaption.
discrimination in Image proc.

contouring. (2) Checker board effect
(4) Distance measure.

Image Question 2021

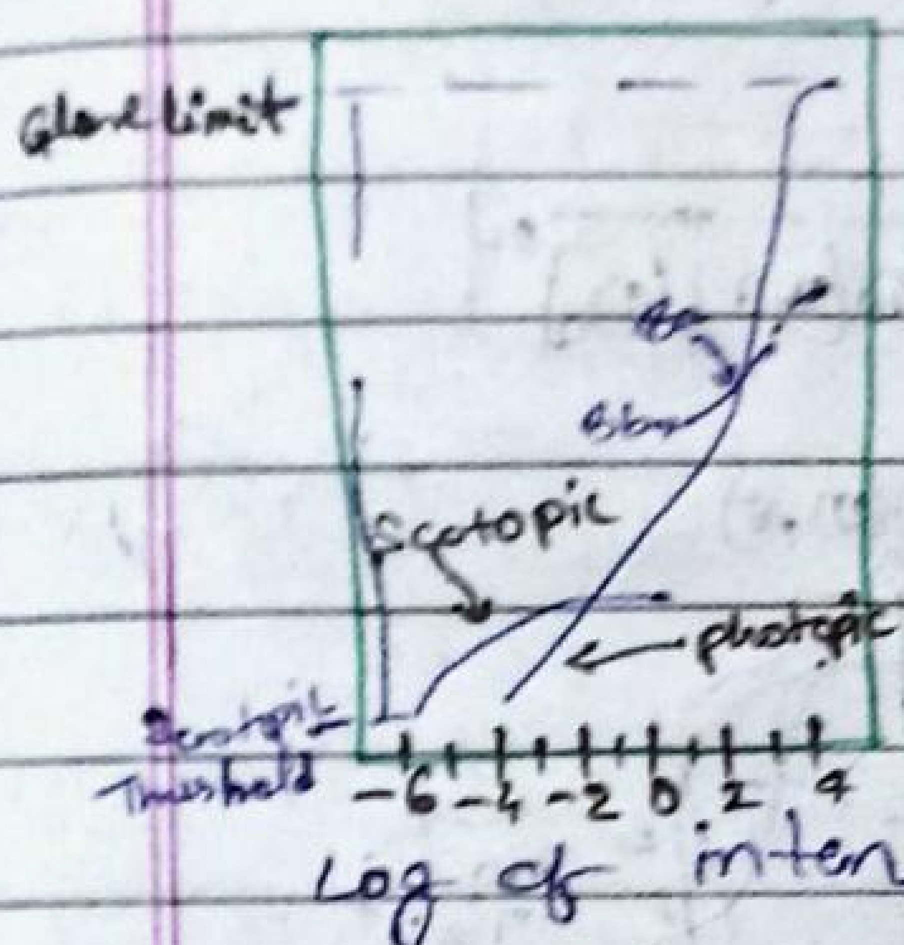
PAGE NO.
DATE: / /20

Brightness Adaption

2021

Ans ① The human eye a wide dynamic range by changing the eye's overall sensitivity and this is called Brightness adaption.

② The eyes ability to discriminate black & white at different intensity levels



③ * Explain the smoothing of images in of image in frequency domain :- ideal, Butterworth and Gausion. Low pass filter.

Soln ⇒ Smoothing (blurring) is achieved in the frequency domain by high - frequency attenuation or low - pass filtering.

▷ Three types of Low pass filters :-
① Ideal ② Butterworth ③ Gaussian.

▷ All filters $\boxed{H(u,v)}$ are understood to be discrete function of size $\boxed{P \times Q}$, i.e. $u = 0, 1, 2, \ldots, P-1$ and $v = 0, 1, 2, 3, \ldots, Q-1$.

Note: Butterworth filter has got a control parameter called filter order. * For higher order it behave like ideal filter and it approaches Gaussian filter for lower order.

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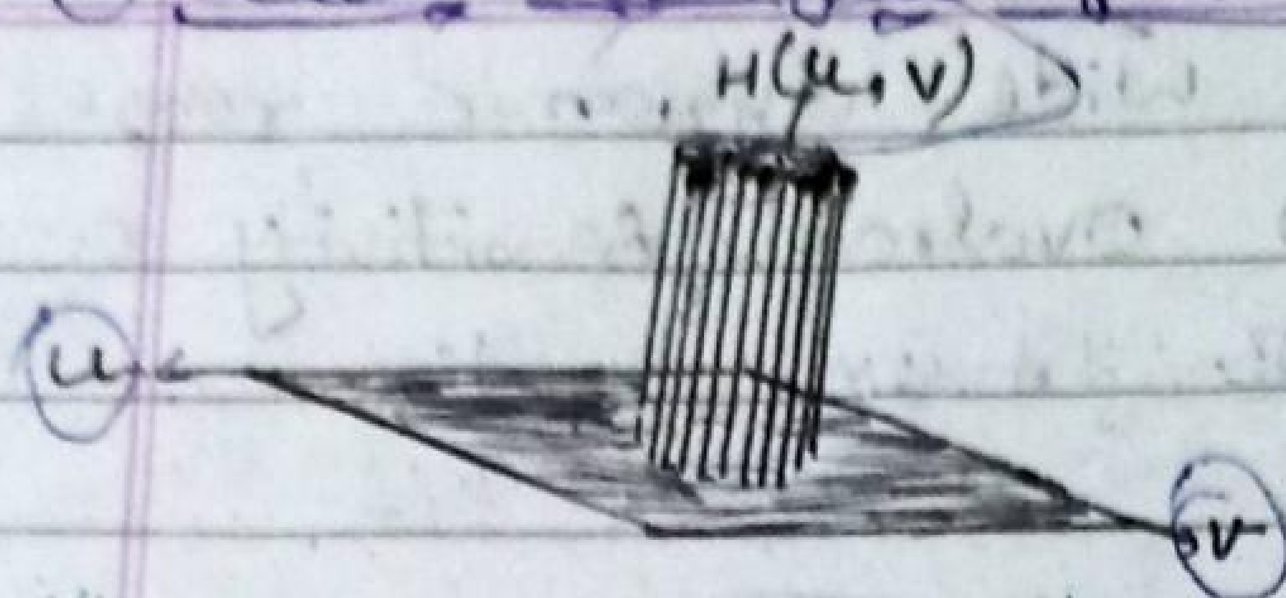
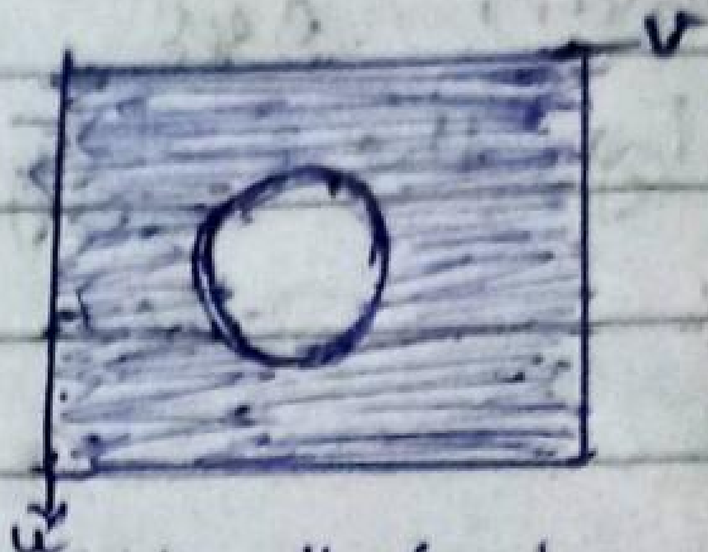
$$\rightarrow D(u,v) = \left[(u - P/2)^2 + (v - Q/2)^2\right]^{1/2}$$

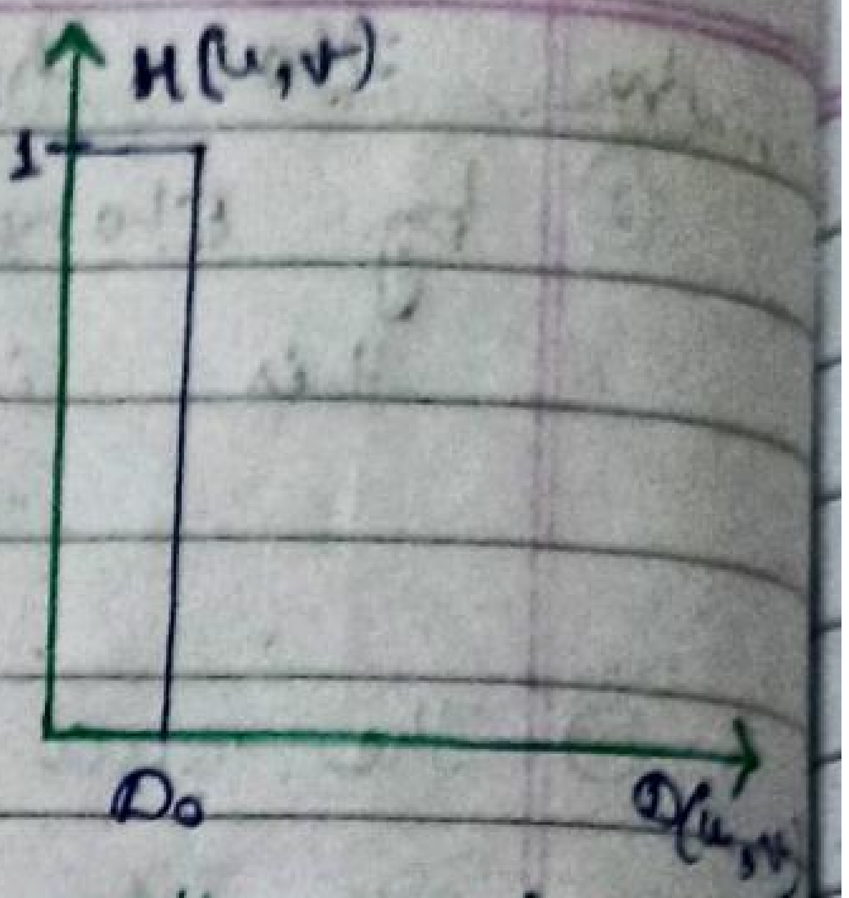
(1) Ideal – low pass filter:



* plot of an ideal filter



* Filter displayed as an image.

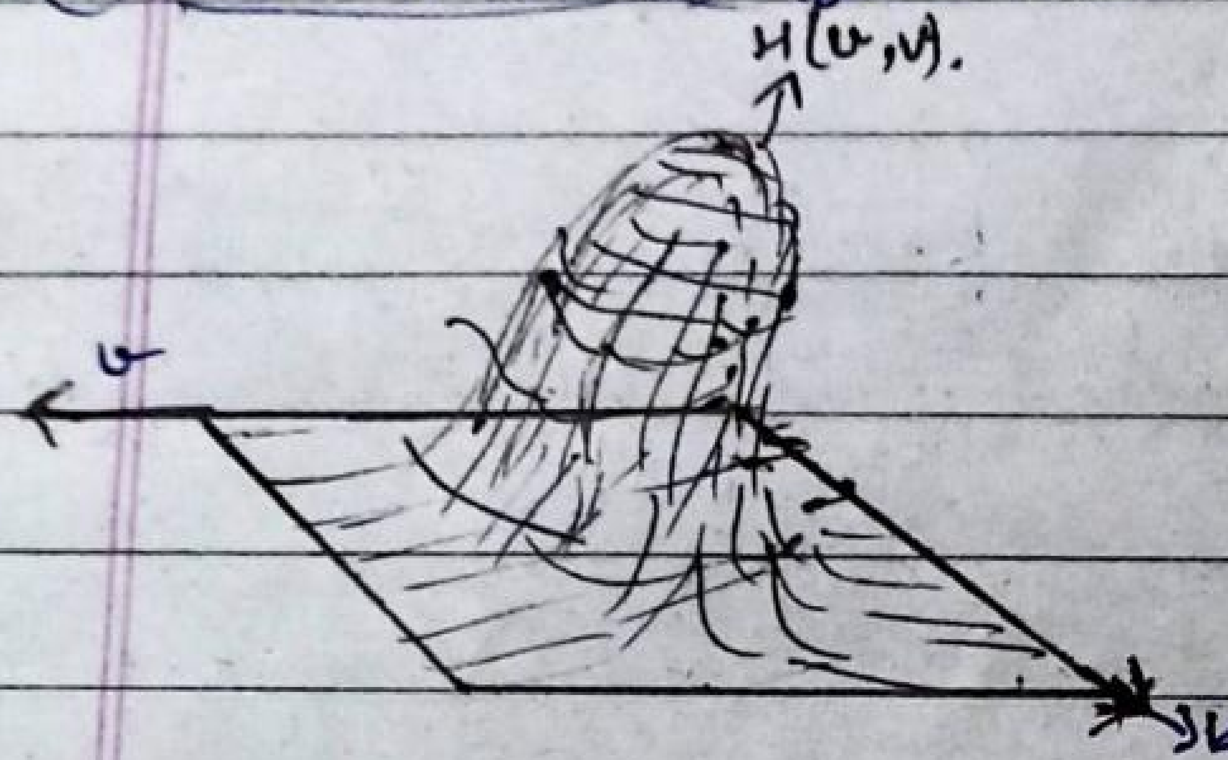


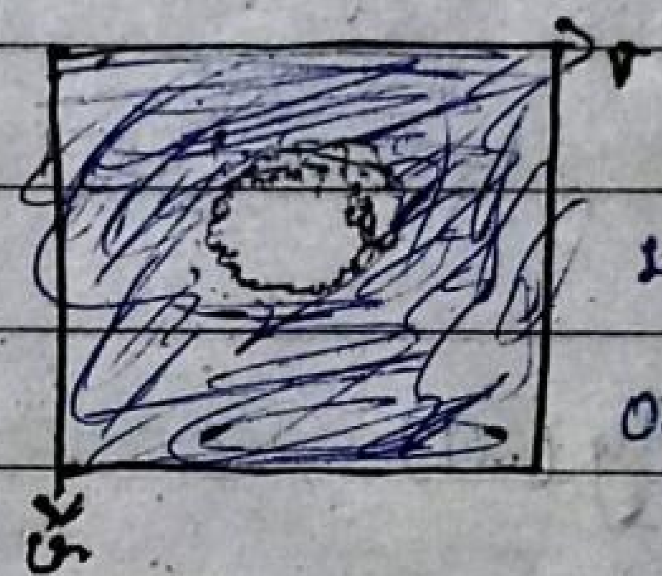
* Filter radial cross section

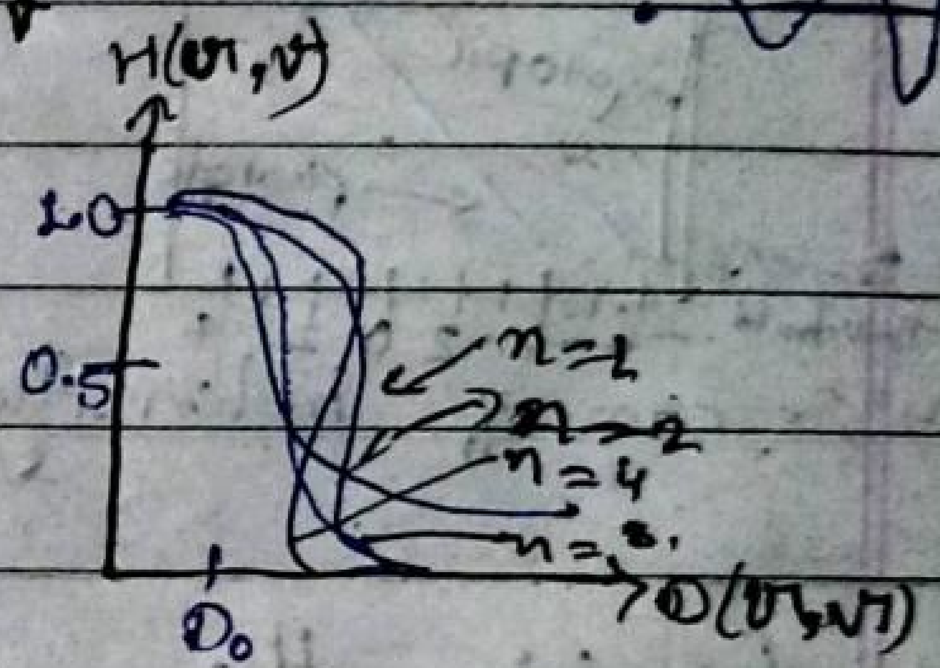
$$H(u,v) = \begin{cases} 1 & \text{if } D(u,v) \le D_0 \\ 0 & \text{if } D(u,v) > D_0 \end{cases}$$

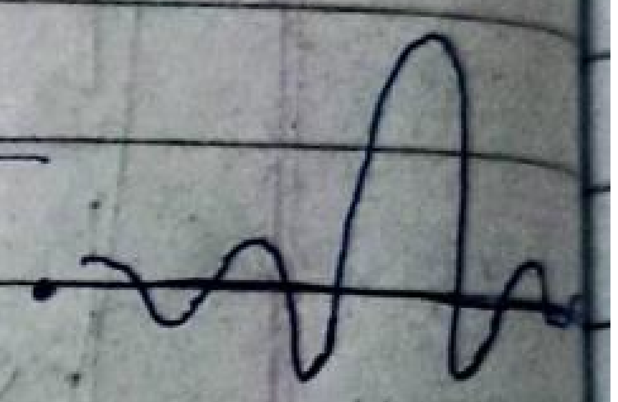
(2) Butterworth (Low) filter:-

$$\boxed{H(u,v) = \frac{1}{1 + [D(u,v)/D_0]^{2n}}}$$



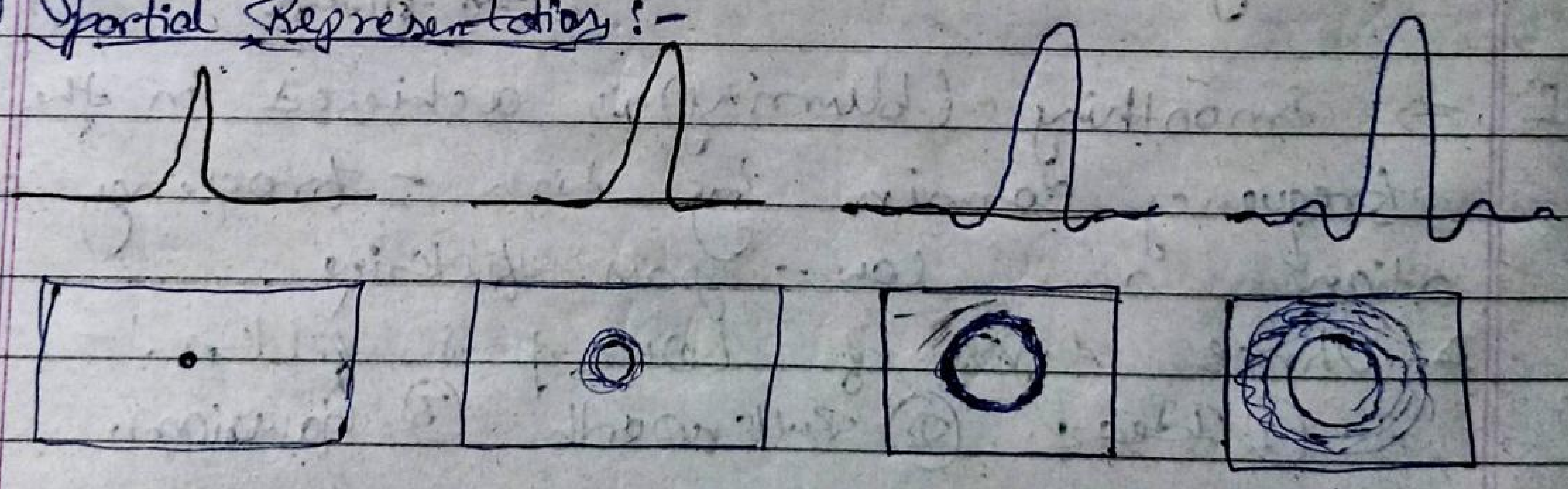






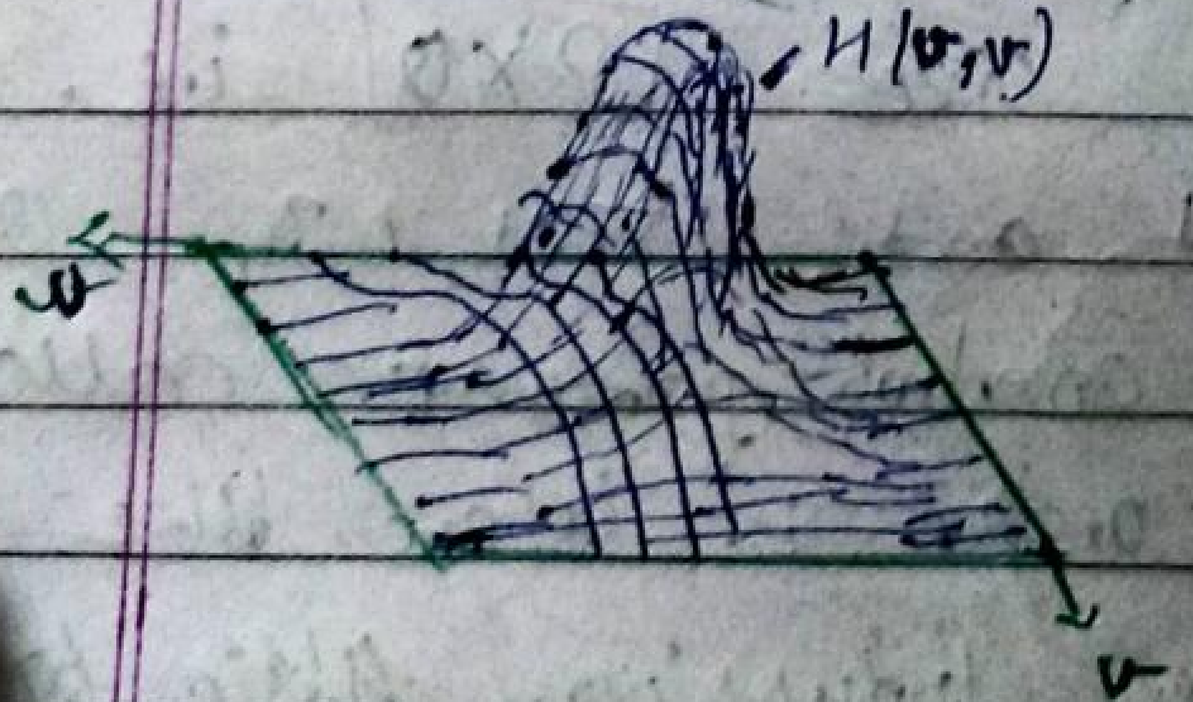
* Same as above

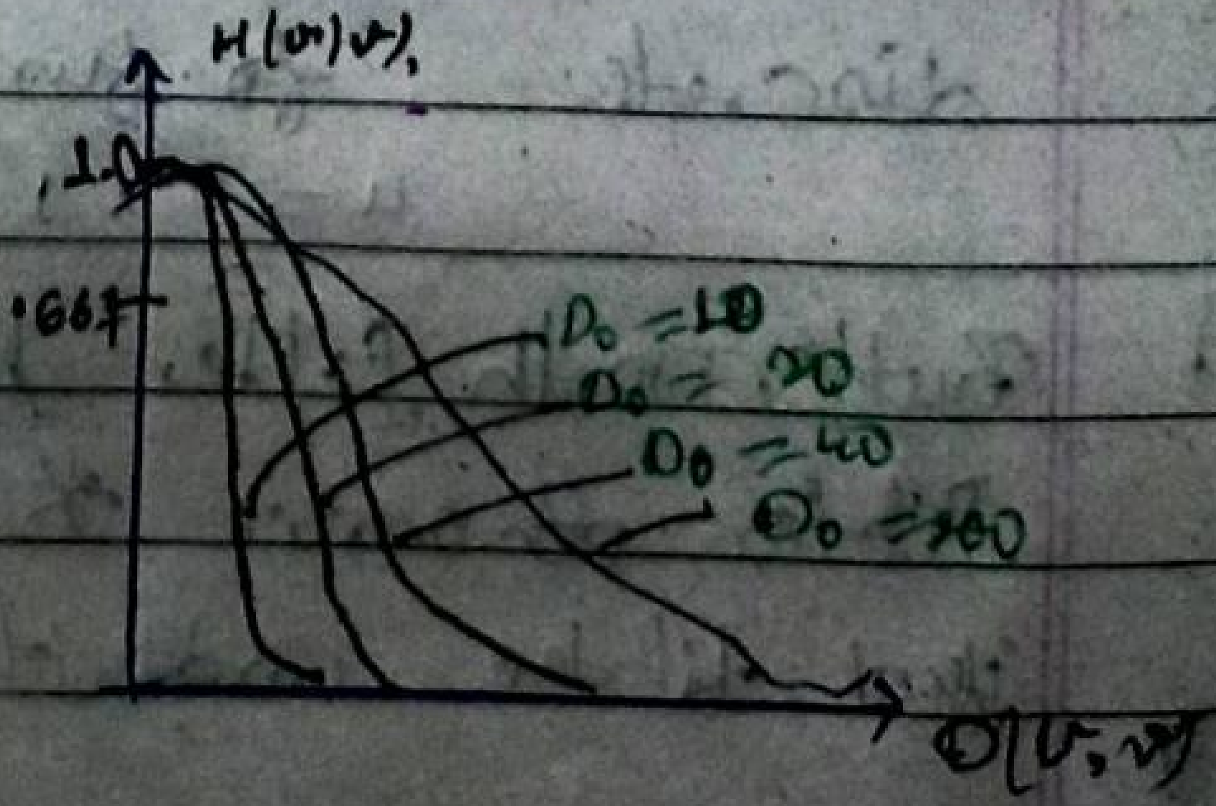
(3) Spatial (Low) Representation:-



(4) Gaussian low Filter:-

$$\boxed{H(u,v) = e^{-D^2(u,v)/2D_0^2}}$$

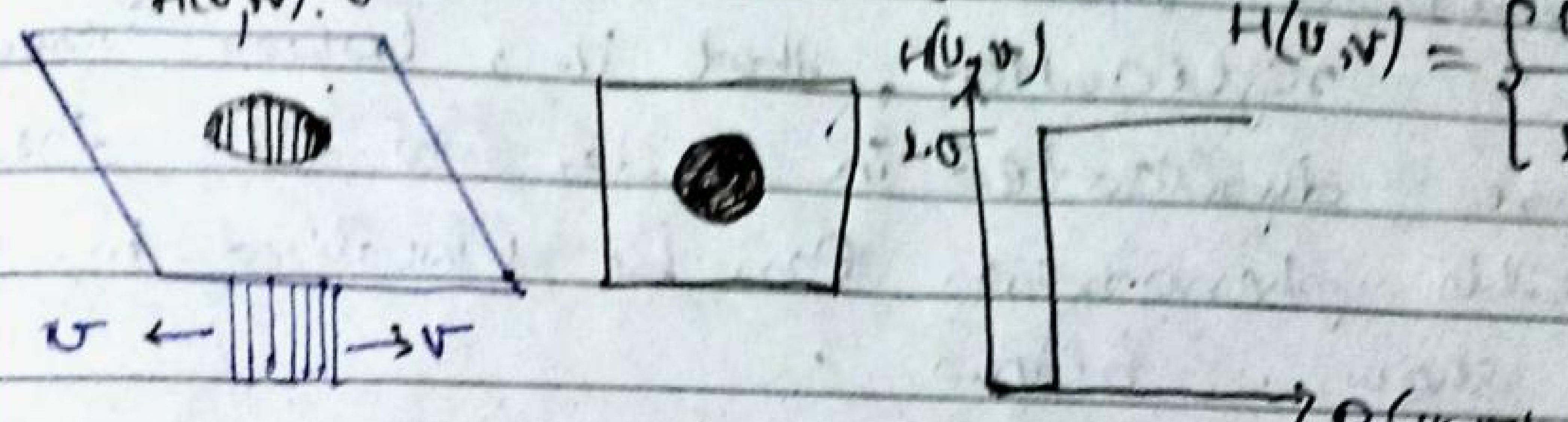




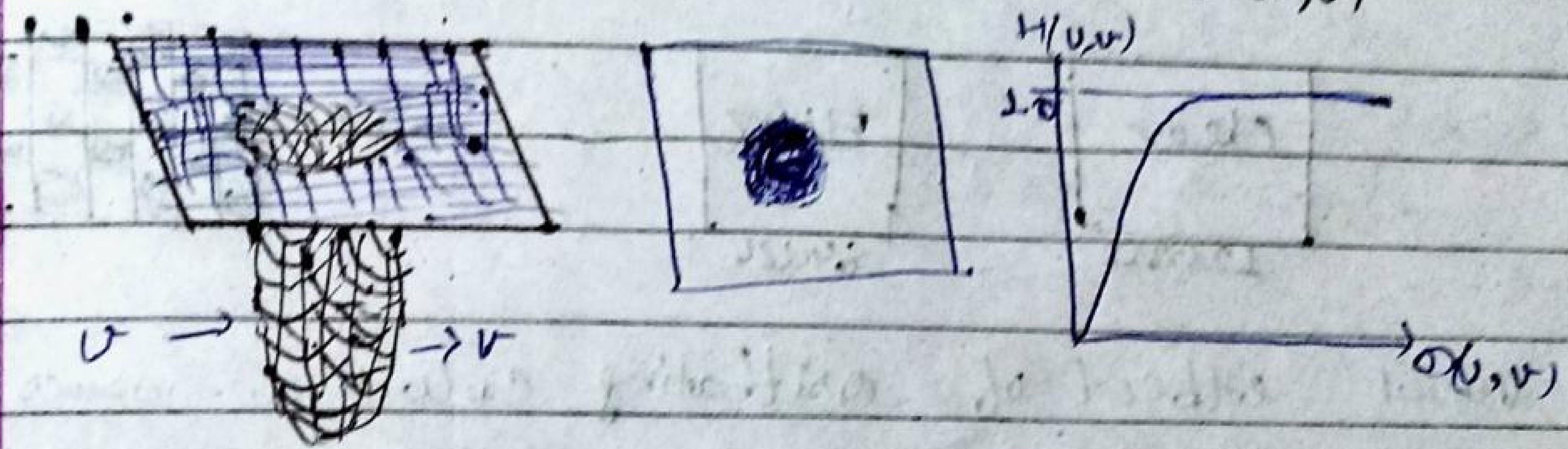
Image

**

(1) Ideal [High] ~~low~~ pass filter.



$$H(u,v) = \begin{cases} 0 & \text{if } D(u,v) \le D_0 \\ 1 & \text{if } D(u,v) > D_0 \end{cases}$$



(2) ButterWorth 'High' filter:-

$$\boxed{H(u,v) = \frac{1}{1+D[D_0/D(u,v)]^{2n}}}$$

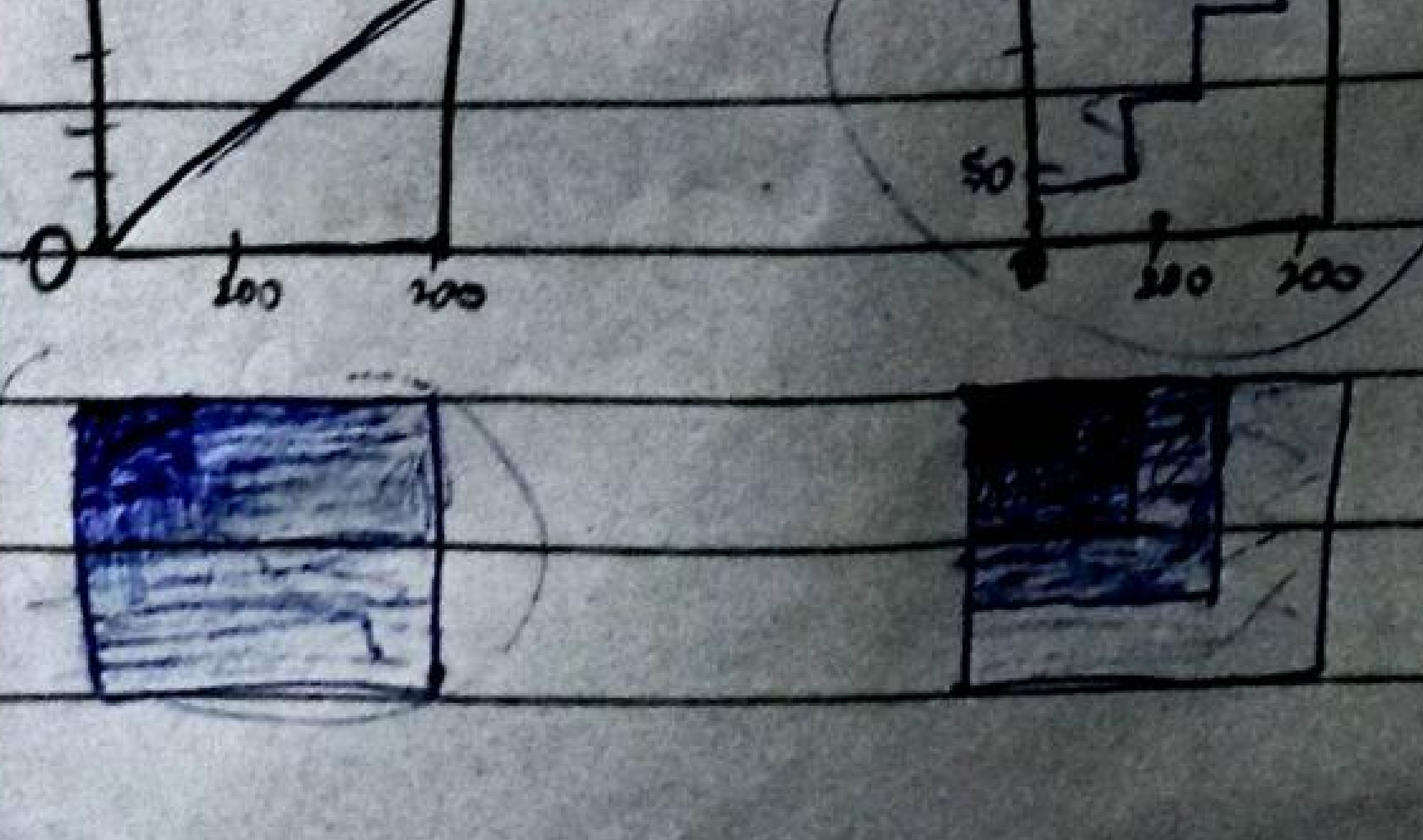
(3) Gaussian High filter:-

$$H(u,v) = \cancel{(u,v)}\ 1 - e^{-D^2(u,v)/2D_0^2}$$

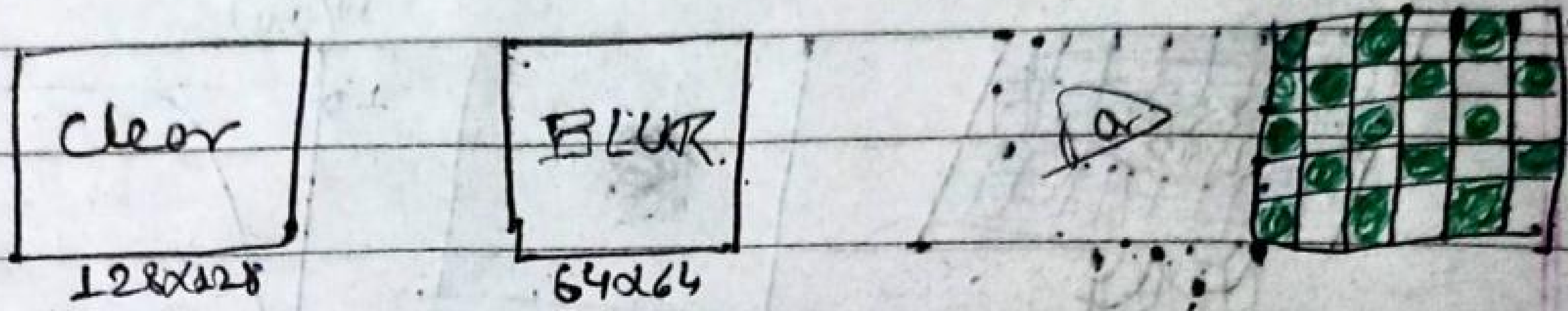
Q:3 (B) *False contouring:- Decreasing the gray-level resolution of a Digital image may result in what is known as false contouring.

Sol^n

> This effect is caused ~~by the~~ use of ~~the~~ an insufficient number of gray levels in smooth area of a Digital image.



(2) Checker-board effect :- It caused by pixel replication, that is, lower resolution images were duplicated in order to fill the display area. This phenomenon can be visualized in the images shown below.



The visual effect of oscillating colors or waves to produce a grid in the appearance of a chess or checkerboard.

(3) Distance measure :-

(1) Euclidean Distance

(2) City Block Distance

(3) Chess - Board Distance.

let $P = (x, y)$ $Q = (s, t)$

(1) Euclidean D_e : $= \sqrt{(x-s)^2 + (y-t)^2}$

(2) City Block :- $D_4 = |x - s| + |y - t|$

(3) Chess-Board Distance :- also known as $D_8(P, q)$.

$D_8(P,q) = \max(|x-s|, |y-t|)$

Image process

**

PAGE NO.
DATE: / /20

* Neighbourhood of pixel :- any Image can be represented as follow

(x−1, y+1)	(x, y+1)	(x+1, y+1)
(x−1, y)	(x, y)	(x+1, y)
(x−1, y−1)	(x, y−1)	(x+1, y−1)

③ $N_8(P)$; (x, y) is P; axes y, x.

① $N_4(P)$ 4-Neighbour :- To set horizontal & vertical.

② $N_D(P)$:- The set of 4-Diagonal neighbours.

③ $N_8(P)$ 8-Neighbour :- Union of 4-Neig. & diagon..

① $N_4(P)$ →

	(x, y+1)	
(x−1, y)	(x, y)	(x+1, y)
	(x, y−1)	

②

(x−1, y+1)		(x+1, y+1)
	(x, y)	
(x−1, y−1)		(x+1, y−1)

③ $\boxed{N_8(P) = N_4(P) + N_D(P)}$

$N_8(P)$

② Connectivity :- or Adjacency (Two pixel that are neighbours and have the same gray level are adjacent.

(a) 4-adjacency

Binary image **

0	1	0	1
0	0	1	0
0	0	1	0
1	0	0	0

8 adjacency connect

4 adjacency connect *

$\boxed{V = \{1\}}$

** Not connected because neighbours are zero.

(b) 8-adjacency

Gray-scale image

8 Adjacency

54	10	100	8
81	150	2	34
201	200	3	45
7	70	177	56.

4-adjacency

Neighbour not matching

$\boxed{V = \{1, 2, 3, \ldots 10\}}$

** Only these can make connection.

PAGE NO.
DATE : / /20

② Ⓒ Mixed (m) — Adjacency :-

$\boxed{V = \{1\}}$

```
0 · 1 — 1        · 0  1  1          0  1  1
0   1    0         0  1  0          0  1  0
0   0    1         0  0  1        · 0  0  1

           0   1 — 1
           0   1    0
           0   0    1
```

$\boxed{m \text{ - adjacency}}$

Priority: 4-Adjacency ✓
8-Adjacency ✗

Q. ④

Gray level r_k :-	0	1	2	3	4	5	6	7
No of pixel n_k :-	0	0	0	6	14	5	0	0

Sol^n

GL r_k	N.P n_k	PDF $\frac{n_k}{N}$	CDF r_k (s_k)	$s_k \times 7$	Hist eq.
0	0	0	0.0	0	0
1	0	0	0.0	0	0
2	0	0	0.0	0	0
3	6	0.24	0.24	1.68	2
4	14	0.56	0.80	~~3.92~~ 5.6	6
5	5	0.20	1	~~5.67~~	7
6	0	0	1	7	7
7	0	0	1	7	7

$n = \boxed{25}$

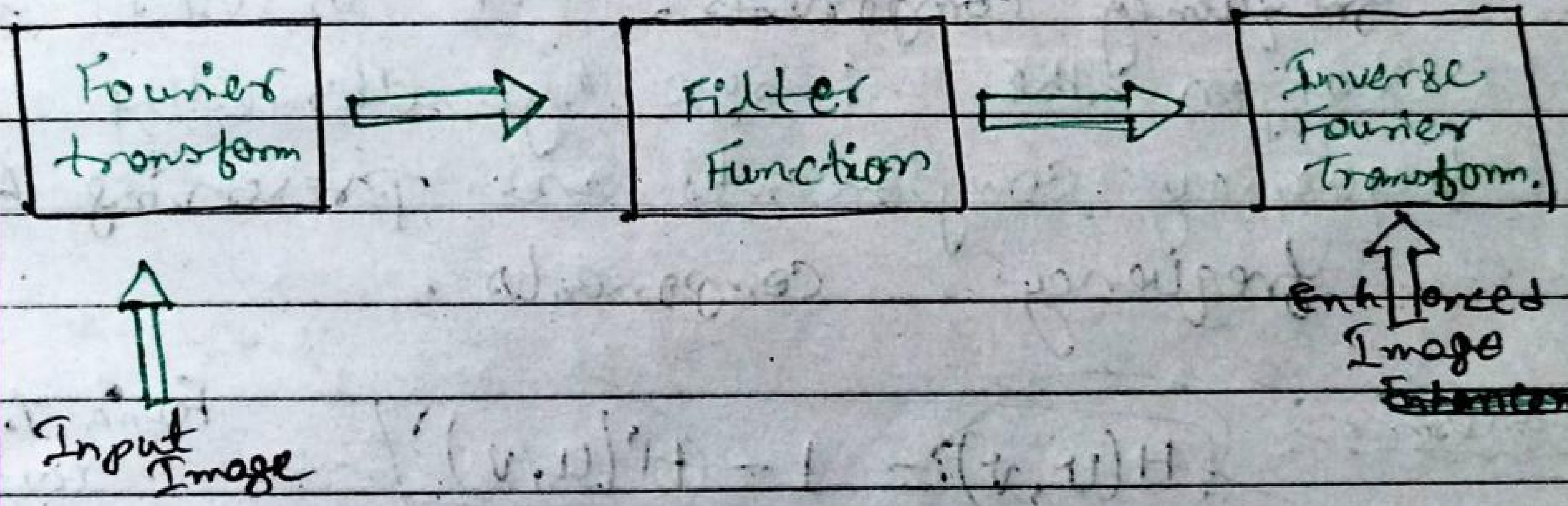
Gray level	0	2	6	7
Pixels	0	6	14	5

Ans.

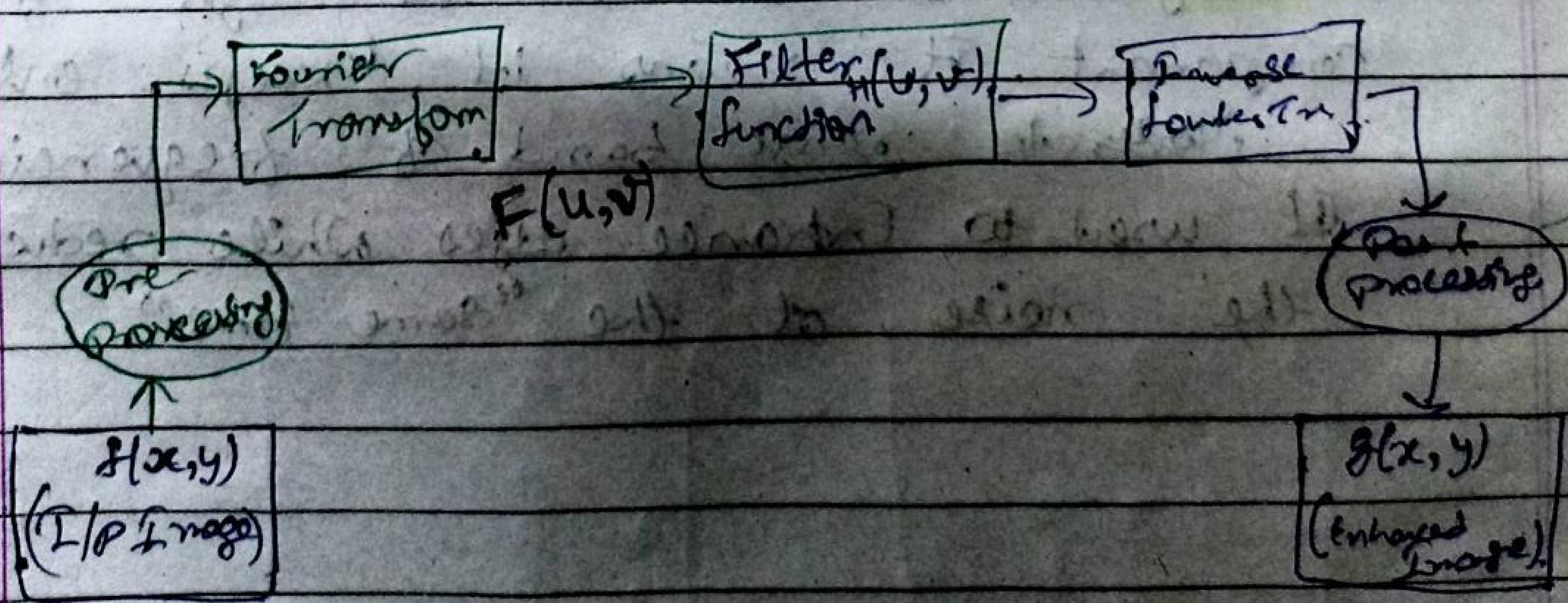
4(B) Explain with the Block Diagram, the basic steps for image ~~processing~~ filtering in ~~fft~~ frequency domain.

Sol^n Basic steps of frequency domain filtering.

The filtering in the spartial domain demands a filter mask (it also referred as kernel ~~or~~ convolution filter)
The filter mask is a Matrix of odd usually size which is applied directly on the original data of the image.



* Frequency domain methods:-
① Filtering ② Homomorphic Filtering



Filters

PAGE NO. DATE: / /20

1) Low pass filter:- It removes the "high frequency component" that means it keeps low frequency components. It is used to "smoothing the image."

Mechanism:

$$G(u,v) = H(u,v) \cdot F(u,v)$$

F.T. of filtering mask

Fourier transform of original img.

2) High pass filter:- It removes "low frequency" components that means it keeps high frequency components. "It is used to sharpen the image by attenuating low frequency components and preserving high frequency components.

Mechanism:- $H(u,v) = 1 - H'(u,v)$

Fourier T. of High pass filter.

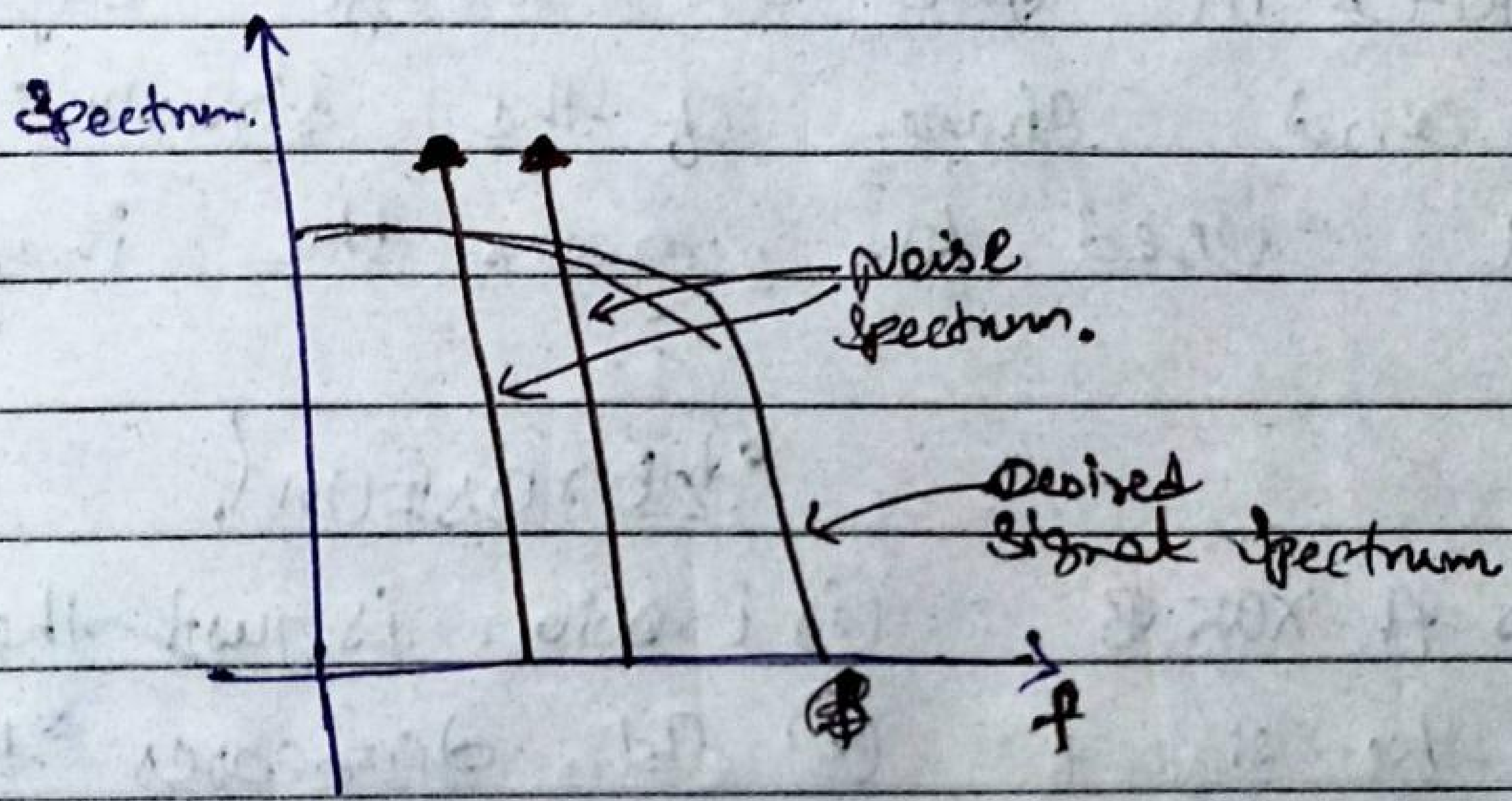
Fourier T. of low pass filter

3) Band pass filter:- This removes the "very low" frequency component as well as "very high" frequency component. It means it keeps only moderate range band of frequencies. It uses to Enhance edges while reducing the noise at the "same time."

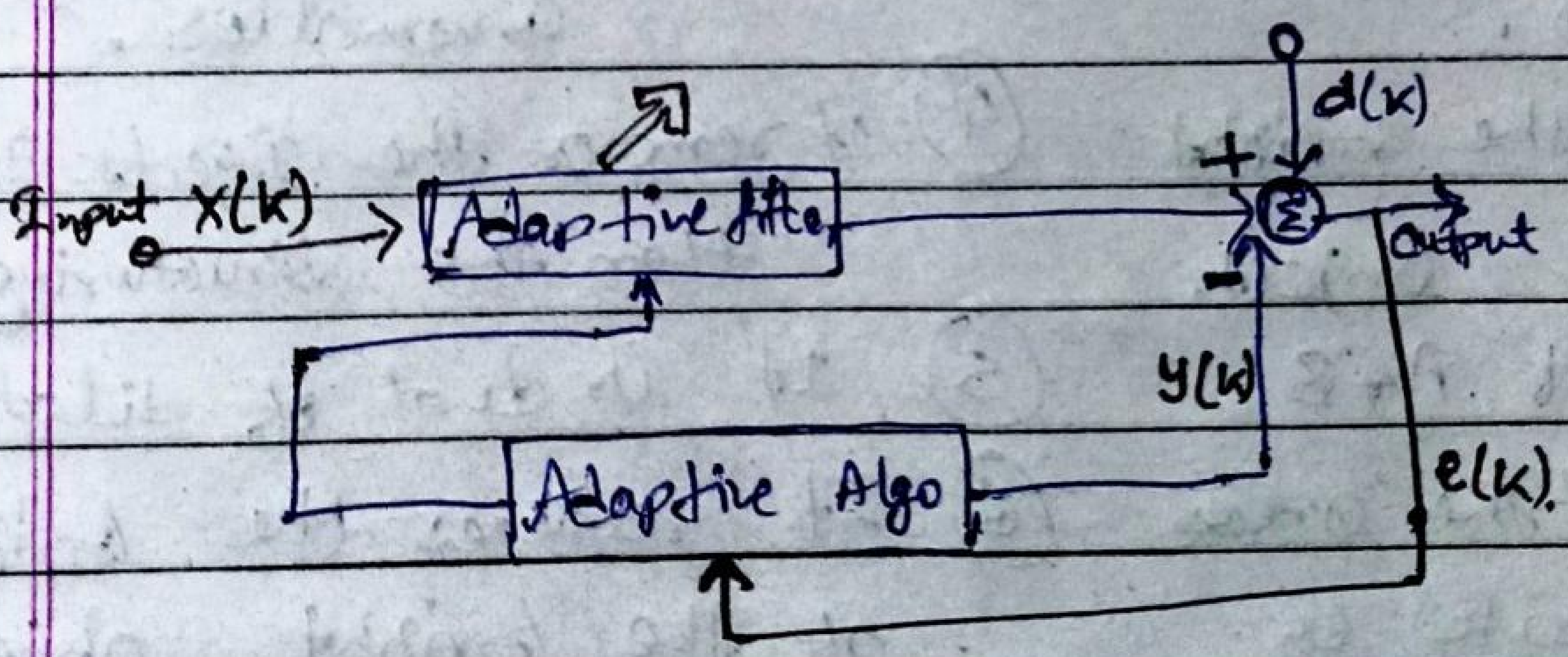
PAGE NO.
DATE: / /20

Q) Explain adaptive filtering method of restoring images. List its Advantages

Ans: Adaptive filters are commonly used in image processing to enhance or restore data by removing noise without significantly blurring the structures in the image.



* Configuration of an Adaptive filter *



"Both produced by "Structuring element" (SE). Erosion & dilation,

Q.5(b) Explain erosion and dilation operations used for Morphological processing.

Ans. (1) Dilation adds pixels to the boundaries of objects in the image, while;
(2) Erosion removes pixels on object boundaries
The no. of pixels added or removed from the objects in ~~the~~ an image depends on the size and shape of the structuring element used for process the image.

Represented by (⊖)

• Dilation

(1) Dilation is A XOR B.
(2) It increases the size of the object.
(3) It fills the holes & broken areas.
(4) It increases the brightness of the object.
(5) It is XOR of A & B
(6) It connects the areas that are seperated by space smaller than (SE).
(7) It used prior in closing operation

• Erosion

(1) Erosion is just the "Dual of Dilation"
(2) It decreases the size of the objects
(3) It removes the small anomalies.
(4) It removes the objects smaller than the structuring elements.
(5) It is dual of dilation.
(6) It reduces the brightness of the bright object.
(7) It used 'later' in closing operation

Eg. Dilation of Binary

It takes only from (D4) neighbour.

1 1 1 | 1

1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1

I/p image

1	1
1	0
0	0
0	0
0	0

O/p Image

* Morphological Dilation of a Gray scale Image.

[1 1 1]

16	19	19	17
53	57	61	62
126	128	127	129
132	130		
140	138		

I/P Img.

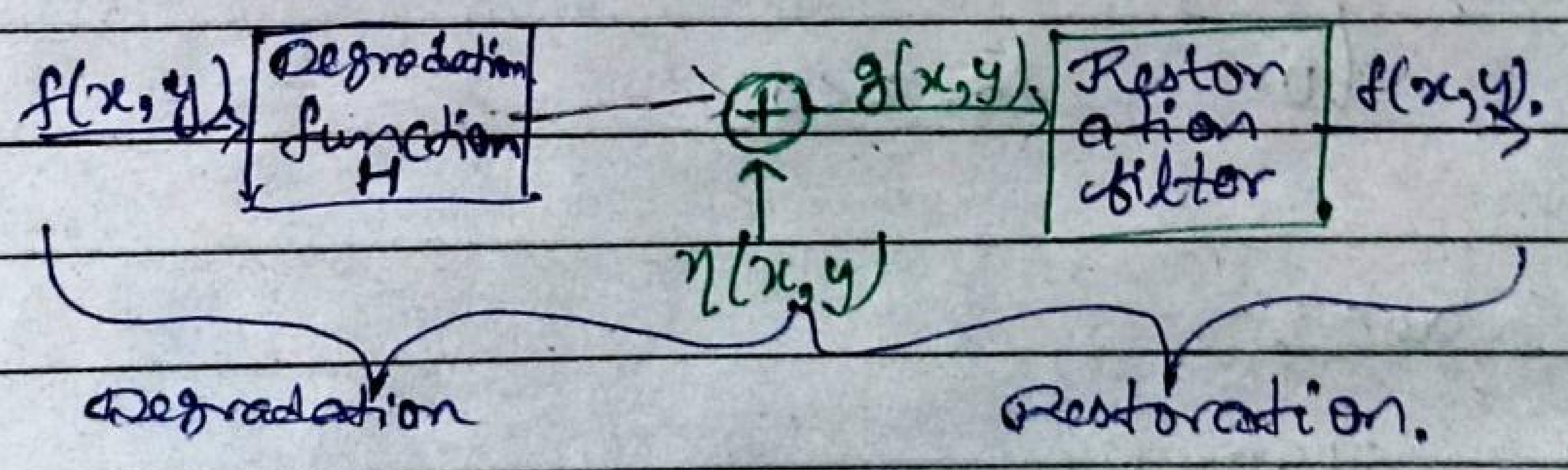
16	16
57	
128	
132	
140	

O/P Img.

Q.6 Explain Basic Model of Image restoration process

As Explain any four important noise probability density function

Soln Image restoration is the process of recovering an image that has been degraded by some knowledge of degradation function H & the additive noise term $\eta(x,y)$. In restoration Degradation is modelled and its inverse process is applied to recover the original image



(1) Degraded image is given in spatial Domain by:-

$$\boxed{g(x,y) = h(x,y) * f(x,y) + \eta(x,y)}$$

(2) Degraded image is given in frequency domain:-

$$\boxed{G(u,v) = H(u,v)F(u,v) + N(u,v)}$$

Some Important Noise Probability (Density function)

(1) Gaussian noise:-

$$P(z) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-(z-\bar{z})^2/2\sigma^2}$$

(2) Ray-length noise:-

$$P(z) \begin{cases} \frac{2}{b}(z-a)e^{-(z-a)^2/b} & \text{for } \boxed{z \geq a} \\ 0 & \text{for } \boxed{z < a} \end{cases}$$

$$\boxed{\sigma^2 = \frac{b(4-\pi)}{4}}$$

(3) Erlang (gamma) noise:-

$$P(z) = \begin{cases} \frac{a^b z^{b-1}}{(b-1)!} e^{-az} & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases}$$

(4) Exponential noise:-

$$P(z) \begin{cases} ae^{-az} & \text{for } z \geq 0 \\ 0 & \text{for } z < 0 \end{cases}$$

(5) Uniform Noise:-

$$P(z) = \begin{cases} \frac{1}{b-a} & \text{if } a \leq z \leq b \\ 0 & \text{otherwise} \end{cases}$$

(6) Impulse (salt and pepper) noise:-

$$P(z) = \begin{cases} P_a & \text{for } z = a \\ P_b & \text{for } z = b \\ 0 & \text{otherwise} \end{cases}$$

Types of restoration filters

1. Inverse filter
2. Pseudo Inverse filter
3. Wiener filter.

PAGE NO.
DATE: / /20

(6)(B) Explain in brief, 2-D Fourier transform properties.

Sol^n
- Linearity → • Scaling → • Differentiation →
- Convolution → • Frequency shift → • Time shift.

Q(7)(A) Explain Wiener filtering in Image processing

Sol^n Wiener filter (minimum mean square Error filter). It executes and optimal trade off b/w filtering and noise smoothing. It Removes the additional noise and inputs in the blurring simultaneously. Weiner filter is real and even. It minimizes the overall mean square error by :-

$\boxed{e^2 = E\{(f-f')^2\}}$; $\boxed{f = \text{original Img}}$ $\boxed{f' = \text{restored Image}}$

$E\{.\} \rightarrow$ mean value of argument.

$\boxed{H(u,v) = H'(u,v) / (|H(u,v)|^2 + (Sn(u,v)/Sf(u,v))}$

* ~~No Blur only additive Noise:-~~

$\Rightarrow \boxed{W(u,v) = 1/(1+Sn(u,v)/Sf(u,v))}$; $\boxed{W(u,v) = SNR/(1+SNR)}$

$\boxed{SNR = Sf(u,v)/Sn(u,v)}$

* No Noise only blur:-

$Sn(u,v) = 0$

$\boxed{W(u,v) = 1/H(u,v)}$

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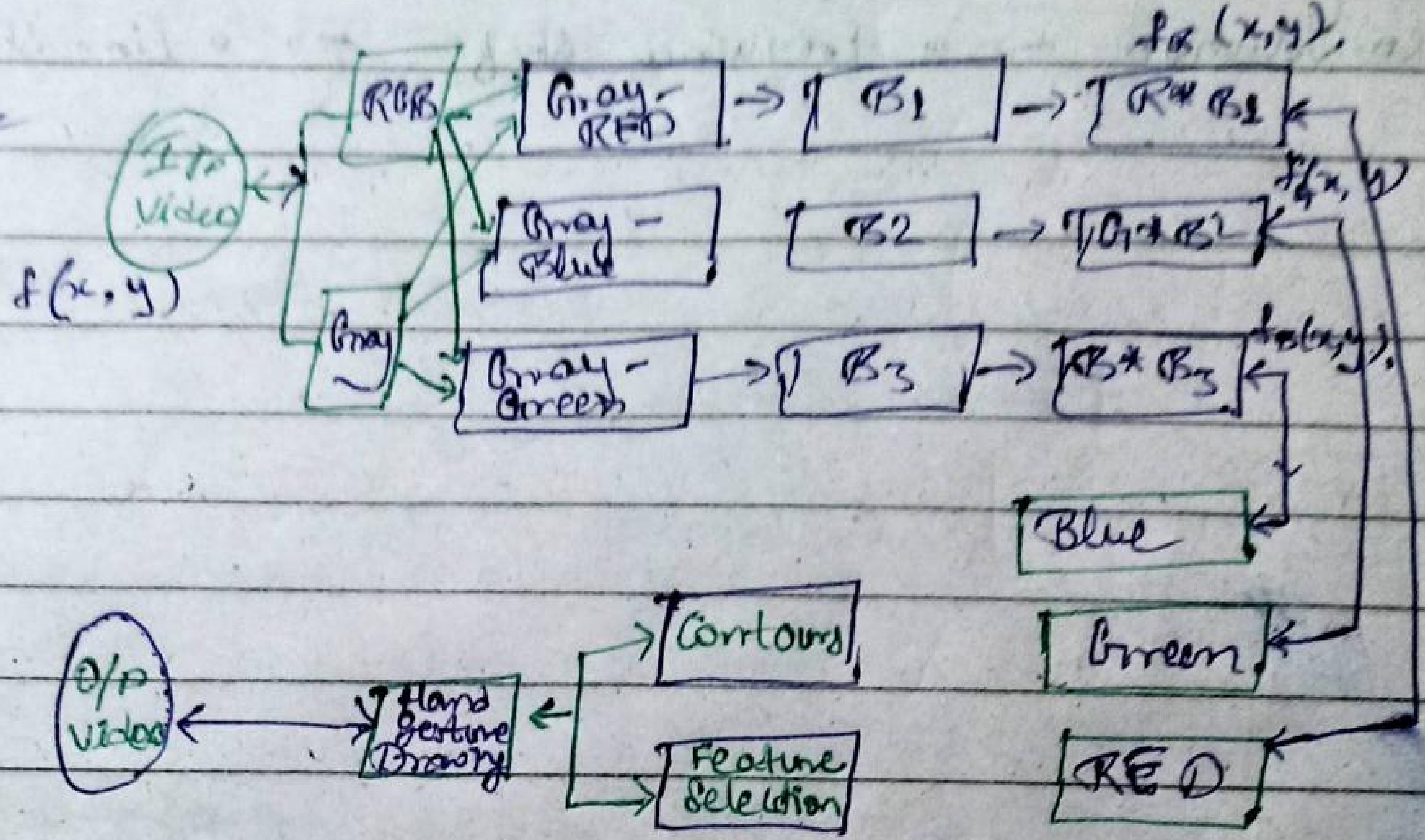
(7) (B) Draw Block Diag. for Converting gray level Intensity to color transform and explain it.

Soln



explain:-

PAGE NO.
DATE: / /20

Question: - Write short Notes:-
(08)

(a) Uniform and Non-Uniform Quintization.
(b) Perspective projection.
(c) Band pass filter
(4) Edge linking (5) Boundary Detection:-

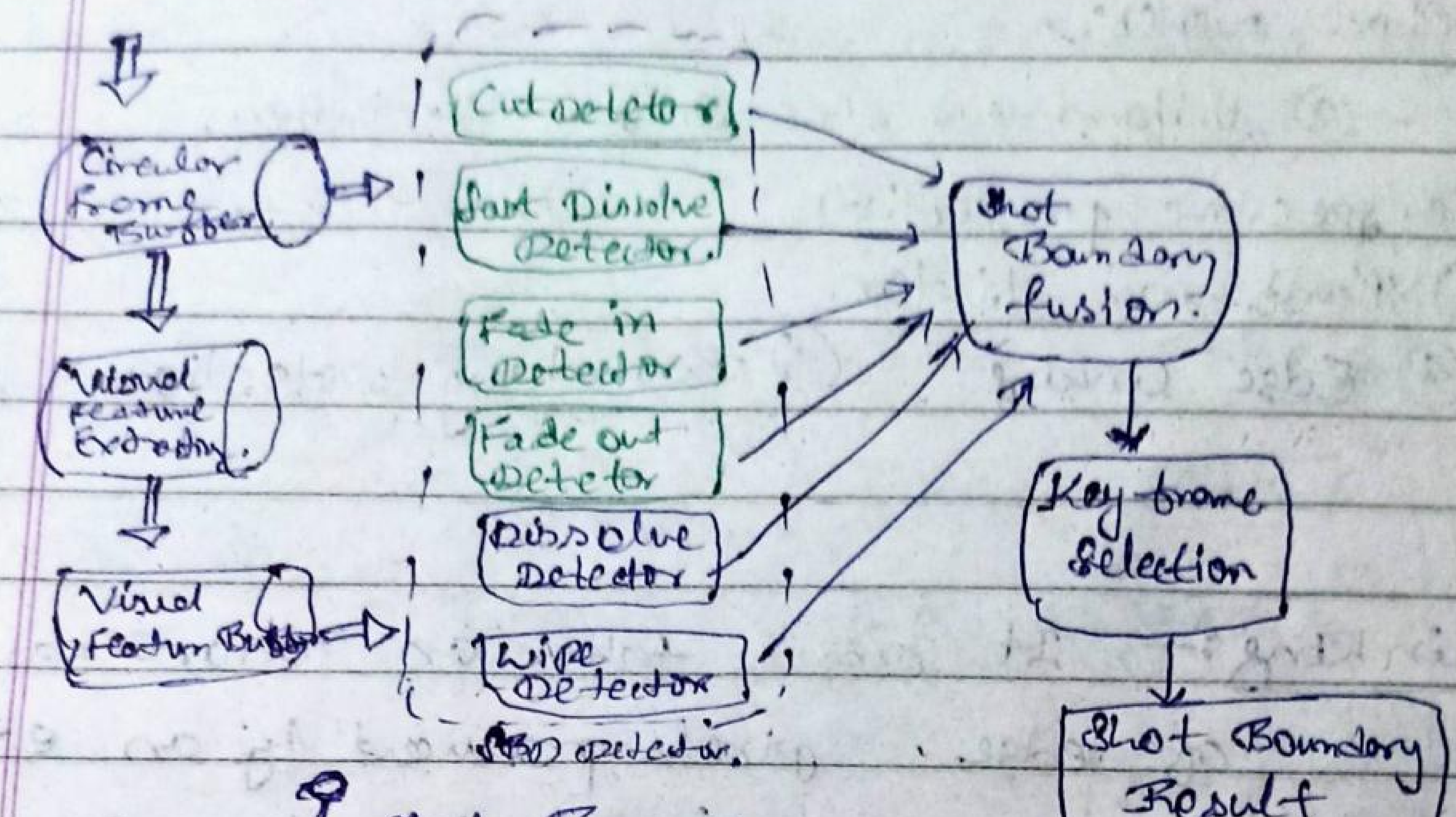
(4) Edge linking:- It process takes an Unordered set of edge pixels produced by an edge Detector as an input to form an ordered list of edges.

* Three types of edge:- • Horizontal • vertical • Diagonal
* Edge Detection :- • pattern • Image • Feature Extraction.

edge Detection operators:- (1) Gradiant (2) Gaussian.

- Gradiant
  - → Sobel oper.
  - → Prewit
  - → Robert
- Gaussian
  - → Canny edge Detector
  - → Laplacian of Gaussian.

(5) Boundary Detection:- We need to find object Boundaries from Edge pixels.



Shot Boundary Detection Algo

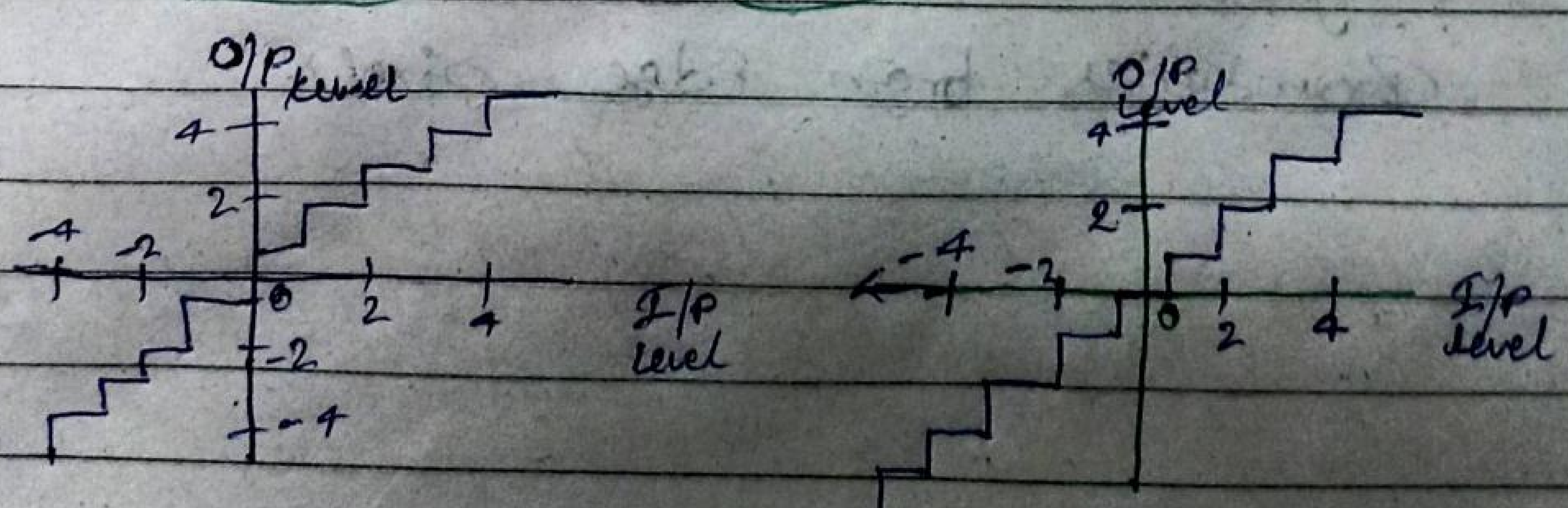
(1) Uniform & Non-Uniform Quantization:-

Soln The type of quantization in which the quantization levels are uniformly spaced ~~by~~ is termed as a Uniform Quantization.

Or

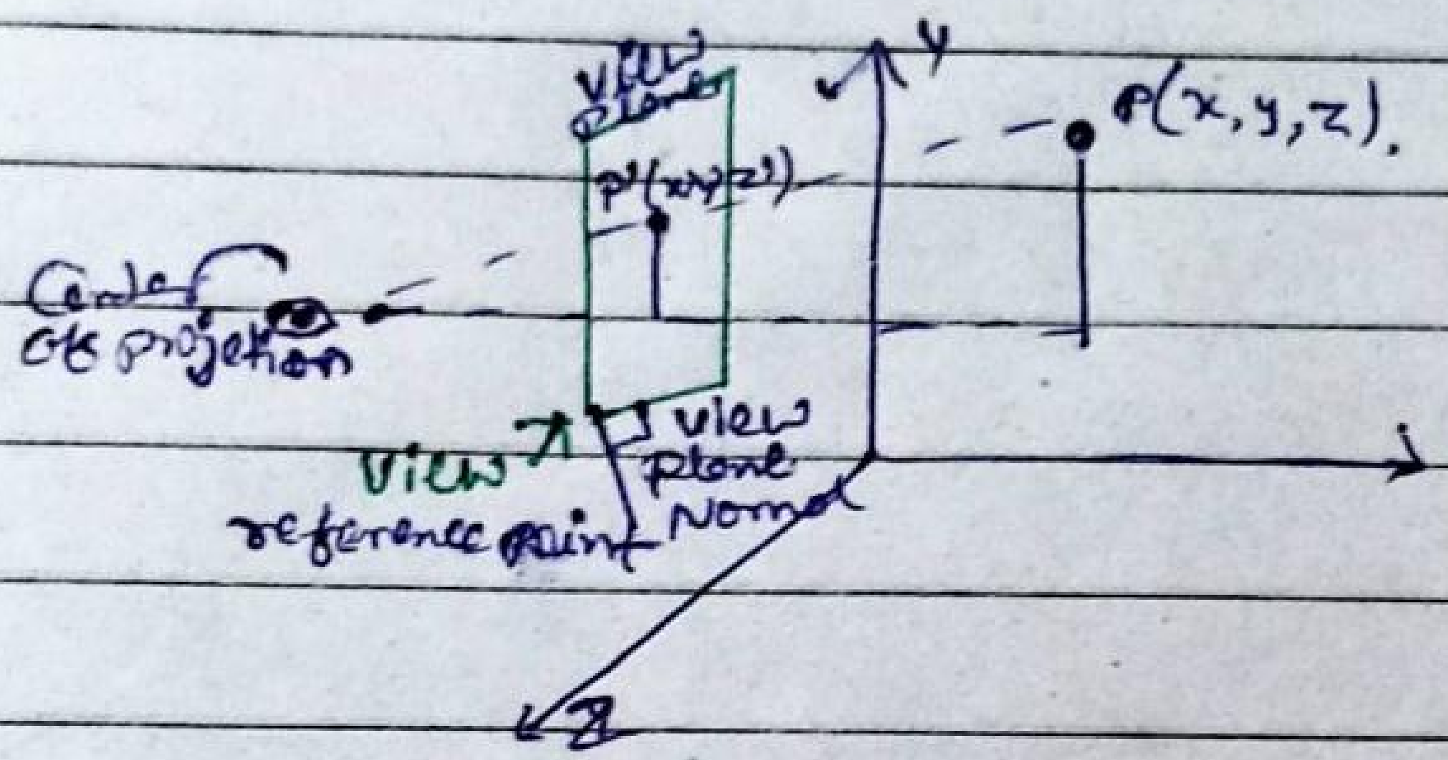
~~the~~ The type of Quantization in which the Quantization levels are ~~the~~ unequal and mostly the relation b/w them is logarithmic, is termed as a Non-uniform Quantization

Uniform
- Mid-Rise
- Mid-Tread



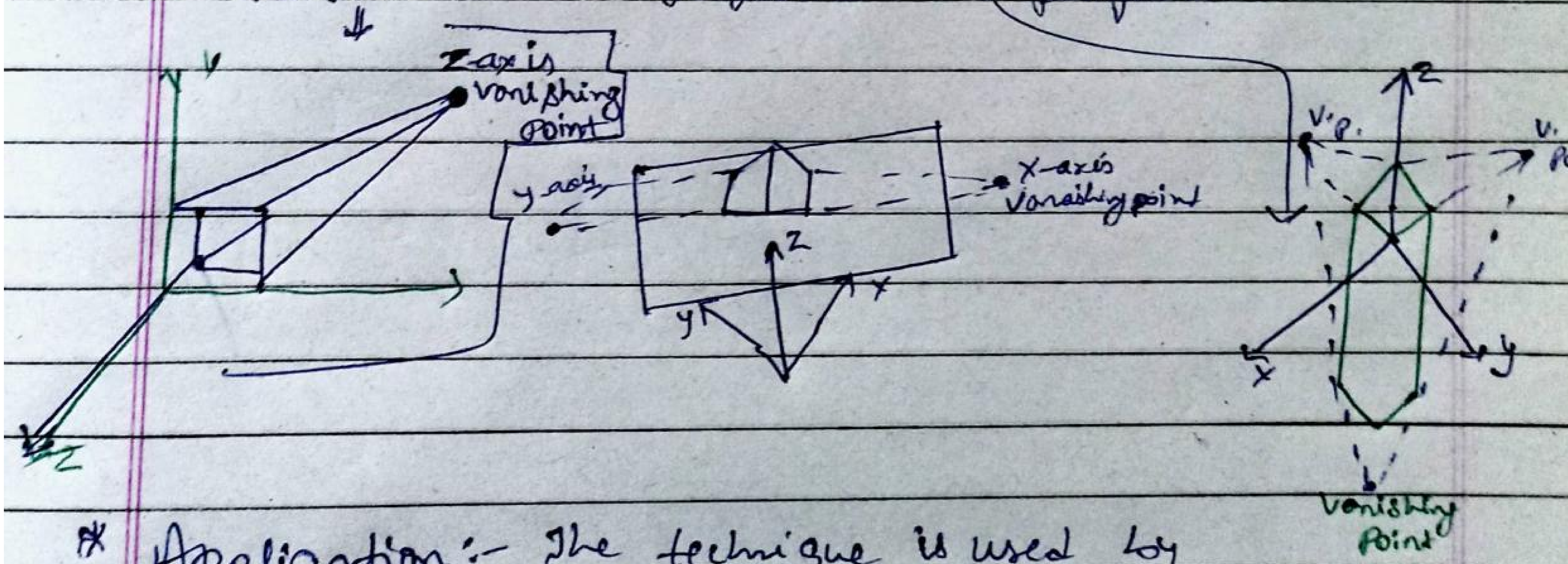
PAGE NO.
DATE: / /20

(3) ~~pro~~ **Perspective Projection:-** the center of projection is at finite distance from projection plane. The projection produces realistic views but doesn't preserve relative proportions of an object Dimension.



* Types of Perspective projection *

- One-point perspective
- Two-point perspective
- Three-point perspective



* **Application:-** The technique is used by artist in preparing drawing of Three (3-D) Dim. objects & scene.