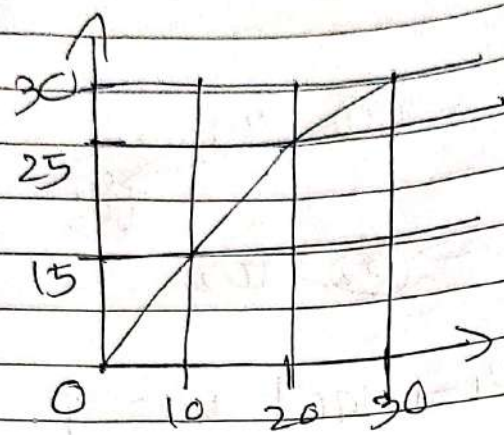
Assignment 3

Q.1



$$\text{Now; } S = \begin{cases} \alpha r & 0 \le r \le 10 \\ S_1 + \beta(r-10) & 10 < r \le 20 \\ S_2 + \gamma(r-20) & 20 < r < 30 \end{cases}$$

$$\alpha = \frac{15-0}{10-0} = 1.5, \quad \beta = \frac{25-15}{20-10} = 1, \quad \gamma = \frac{30-25}{30-20} = 0.5$$

$S_1 = 15, \quad S_2 = 25$

$$S = \begin{cases} 1.5r & 0 \le r \le 10 \\ 15 + (r-10) & 10 < r \le 20 \\ 25 + (r-20)0.5 & 20 < r \le 30 \end{cases}$$

Q.2

$$S = \begin{cases} \alpha r & 0 \le r \le 8 \\ 4 + \beta(r-8) & 8 < r \le 12 \\ 8 + \gamma(r-12) & 12 < r \le 15 \end{cases}$$

$$\alpha = \frac{4-0}{8-0} = \frac{1}{2}, \quad \beta = \frac{8-4}{12-8} = \frac{4}{4} = 1,$$

$$\gamma = \frac{15-8}{15-12} = \frac{7}{3}$$

$$S = \begin{cases} 0.5r & 0 < r \le 8 \\ 4 + 1(r-8) & 8 < r \le 12 \\ 8 + \frac{7}{3}(r-12) & 12 < r \le 15 \end{cases}$$

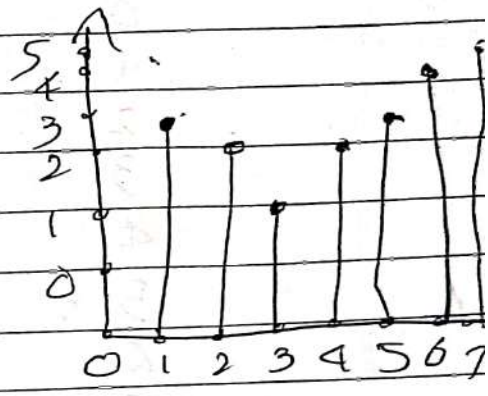
Applying it on image

$$F = \begin{bmatrix} 4 & & & & \\ 3 & 8 & 1 & 22 \\ 6 & 15 & 1 & 34 \\ 8 & 2 & 3 & 158 \\ 4 & 1 & 4 & 151 \\ 7 & 10 & 2 & 23 \end{bmatrix}$$

Q3

Freq table

Gray value	Freq
0	5
1	3
2	2
3	1
4	2
5	3
6	4
7	5



Take 3 as threshold.

$$S = \begin{cases} 0 & r \leq 3 \\ 7 & 3 < r \leq 7 \end{cases}$$

$$F = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 7 & 7 & 7 & 0 \\ 0 & 7 & 7 & 7 & 7 \\ 7 & 7 & 0 & 0 & 0 \\ 7 & 7 & 7 & 7 & 7 \end{bmatrix}$$

q4

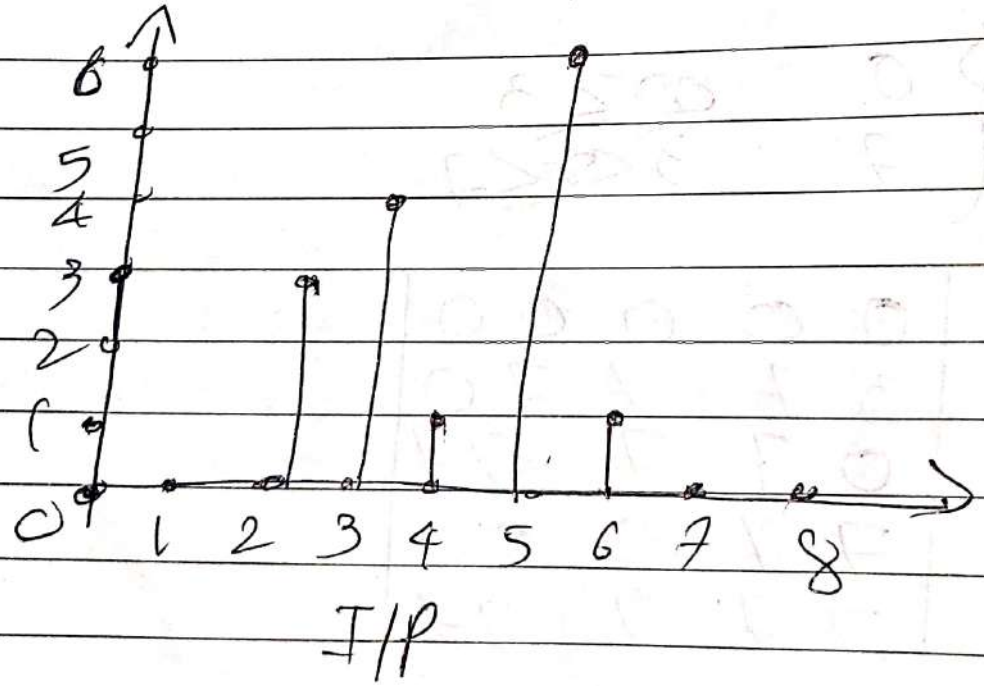
a) $S = \begin{cases} 0 & 0 \le r \le 2 \\ 6 & 2 \le r \le 6 \\ 8 & r > 6 \end{cases}$

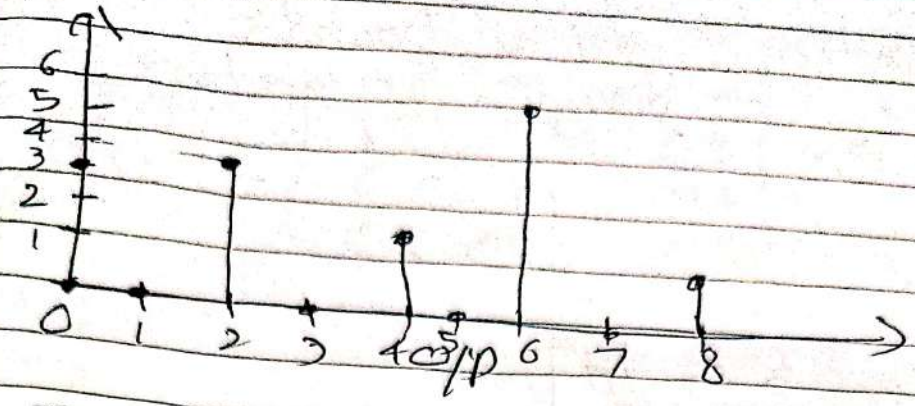
$\alpha = \frac{8-0}{6-2} = 2$

b) $F = \begin{bmatrix} 2 & 5 & 3 & 5 \\ 3 & 6 & 5 & 3 \\ 3 & 5 & 2 & 4 \\ 2 & 5 & 4 & 5 \end{bmatrix} \rightarrow F = \begin{bmatrix} 0 & 6 & 2 & 6 \\ 2 & 8 & 6 & 2 \\ 2 & 6 & 0 & 4 \\ 0 & 6 & 4 & 6 \end{bmatrix}$

c)

Gray levels	original	New
0	0	3
1	0	0
2	3	4
3	4	0
4	1	2
5	6	0
6	1	6
7	0	0
8	0	1





d) In case of i/p image the pixel values were between 2 to 6 which is said to be bad contrast while in o/p it ranges from 0 to 8 making contrast wider making it enhanced.

g.5

$$f(m,n) = \begin{bmatrix} 128 & 212 & 255 \\ 54 & 62 & 124 \\ 140 & 152 & 156 \end{bmatrix}$$

$$g(m,n) = 107 \log_{10}(1+f(m,n))$$

$$= 107 \log_{10} \begin{bmatrix} 129 & 213 & 256 \\ 55 & 63 & 125 \\ 141 & 153 & 157 \end{bmatrix}$$

$$= 107 \times \begin{bmatrix} 2.11 & 2.33 & 2.41 \\ 1.74 & 1.8 & 2.1 \\ 2.15 & 2.18 & 2.19 \end{bmatrix}$$

$$= \begin{bmatrix} 226 & 249 & 258 \\ 187 & 193 & 225 \\ 230 & 233 & 234 \end{bmatrix}$$

∴ 258 goes out of bounds
∴ we can divide the matrix by

$$g(m,n) = \begin{bmatrix} 23 & 25 & 26 \\ 19 & 19 & 23 \\ 23 & 23 & 23 \end{bmatrix} \Rightarrow o/p$$

9.6

$$f = \begin{bmatrix} 2 & 3 & 5 & 10 \\ 4 & 6 & 4 & 10 \\ 7 & 1 & 3 & 3 \end{bmatrix}$$

Normalized image = $\frac{I/P}{\text{Max Pixel value}}$

$$B = \begin{bmatrix} 0.2 & 0.3 & 0.5 & 1 \\ 0.4 & 0.6 & 0.4 & 1 \\ 0.7 & 0.1 & 0.3 & 0.3 \end{bmatrix}$$

$S = B^2$

$$C = \begin{bmatrix} 0.04 & 0.09 & 0.25 & 1 \\ 0.16 & 0.36 & 0.16 & 1 \\ 0.49 & 0.01 & 0.09 & 0.09 \end{bmatrix}$$

De-normalization

$D = C \times 10$

$$D = \begin{bmatrix} 0.4 & 0.9 & 2.5 & 10 \\ 1.6 & 3.6 & 1.6 & 1 \\ 4.9 & 0.1 & 0.9 & 0.9 \end{bmatrix}$$

$$D = \begin{bmatrix} 0 & 1 & 3 & 10 \\ 2 & 4 & 2 & 1 \\ 5 & 0 & 1 & 1 \end{bmatrix}$$

$$S = \begin{cases} 7 & 3 \le \alpha \le 5 \\ \alpha & \text{otherwise} \end{cases}$$

$$F = \begin{bmatrix} 0 & 1 & 0 & 2 & 16 \\ 2 & 7 & 5 & 7 & 16 \\ 2 & 7 & 7 & 7 & 21 \\ 1 & 7 & 7 & 7 & 01 \\ 2 & 12 & 6 & 6 & \end{bmatrix}$$

$$F = \begin{bmatrix} 4 & 2 & 3 & 0 \\ 1 & 3 & 5 & 7 \\ 5 & 3 & 2 & 1 \\ 3 & 4 & 6 & 7 \end{bmatrix}$$

a]

$S = 7$ if $\alpha \ge 4$

$= 0$ otherwise

$$\therefore F = \begin{bmatrix} 7 & 0 & 0 & 0 \\ 1 & 6 & 7 & 7 \\ 7 & 0 & 0 & 0 \\ 0 & 7 & 7 & 7 \end{bmatrix}$$

b] $S = 7 \quad 2 < \alpha < 5$

$= \alpha$ otherwise

$$F = \begin{bmatrix} 7 & 2 & 7 & 0 \\ 1 & 7 & 5 & 7 \\ 5 & 7 & 2 & 1 \\ 7 & 7 & 6 & 7 \end{bmatrix}$$

c] Bit plane slicing (for MSB and LSB planes)

$$F=\begin{bmatrix} 100\ 010 & 011\ 000 \\ 001\ 011 & 101\ 111 \\ 101\ 011 & 010\ 001 \\ 011\ 100 & 110\ 111 \end{bmatrix}$$

S = { if MSB=1 S=7 ; otherwise S=0 }

$$F=\begin{bmatrix} 7 & 0 & 0 & 0 \\ 0 & 0 & 7 & 7 \\ 7 & 0 & 0 & 0 \\ 0 & 7 & 7 & 7 \end{bmatrix}$$

LSB level

S = { if LSB=1, S=7 ; otherwise S=0 }

$$F=\begin{bmatrix} 0 & 0 & 7 & 0 \\ 7 & 7 & 7 & 7 \\ 7 & 7 & 0 & 7 \\ 7 & 0 & 0 & 7 \end{bmatrix}$$

Negate

d] $S=(L-1)-p$

$=7-p$

$$p=\begin{bmatrix} 3 & 5 & 4 & 7 \\ 6 & 4 & 2 & 0 \\ 2 & 4 & 5 & 6 \\ 4 & 3 & 1 & 0 \end{bmatrix}$$

g.9

Gray level	0	1	2	3
No. of Pixel	70	20	7	3

I/P	Norm	Freq	PDF	CDF	Eq. CDF
0	0	70	0.7	0.7	2
1	1/3	20	0.2	0.9	3
2	2/3	7	0.07	0.97	3
3	1	3	0.03	1	3

Gray level	0	1	2	3
No. of Pixel	0	0	70	30

I/P	Norm	Freq	PDF	CDF	Eq. CDF
0	0	0	0	0	0
1	1/3	0	0	0	0
2	2/3	70	0.7	0.7	2
3	1	30	0.3	1	3

∴ Equalizing pixels more than once give same output

g.10

x \ y	0	1	2	3	4	5	6	7
0	0	1	2	3	4	5	6	7
1	1	0	1	2	3	4	5	6
2	2	1	0	1	2	3	4	5
3	3	2	1	0	1	2	3	4
4	4	3	2	1	0	1	2	3
5	5	4	3	2	0	0	1	2
6	6	5	4	3	2	1	0	1
7	7	6	5	4	3	2	1	0

f. Table

I/P	Freq.
0	8
1	14
2	12
3	10
4	8
5	6
6	4
7	2

I/P	Norm	Freq	PDF	CDF
0	0	8	0.125	0.125
1	1/7	14	0.219	0.344
2	2/7	12	0.187	0.531
3	3/7	10	0.156	0.687
4	4/7	8	0.125	0.812
5	5/7	6	0.094	0.906
6	6/7	4	0.063	0.969
7	1	2	0.031	1

Using the above table

$$A = \begin{bmatrix} 1 & 2 & 4 & 5 & 6 & 7 & 7 & 7 \\ 2 & 1 & 2 & 4 & 5 & 6 & 7 & 7 \\ 4 & 2 & 1 & 2 & 4 & 5 & 6 & 7 \\ 5 & 4 & 2 & 1 & 2 & 4 & 5 & 6 \\ 6 & 5 & 4 & 2 & 1 & 2 & 4 & 5 \\ 7 & 6 & 5 & 4 & 2 & 1 & 2 & 4 \\ 7 & 7 & 6 & 5 & 4 & 2 & 1 & 2 \\ 7 & 7 & 7 & 6 & 5 & 4 & 2 & 1 \end{bmatrix}$$

Q.13 $f(x,y) = \begin{bmatrix} 3 & 21 \\ 5 & 26 \\ 7 & 91 \end{bmatrix}$

a) Mask 1

	z_2	
z_4	z_5	z_6
	z_8	

Median = {2, 25, 6, 9}
= 5

b) Mask-2

z_1	z_2	z_3
z_4	–	z_6
z_7	z_8	z_9

Median = {1, 1, 2, 35, 6, 7, 9}
$= \frac{5+3-4}{2}$

c) Mask-3

z_1	z_2	z_3
z_4	z_5	z_6
z_7	z_8	z_9

Median = 3

Q.14

Q.15 $F = \begin{bmatrix} 3 & 2 & 5 \\ 4 & 6 & 7 \\ 7 & 1 & 3 \end{bmatrix}$

$F = \begin{bmatrix} 3 & 3 & 2 & 5 & 5 \\ 3 & 3 & 2 & 5 & 5 \\ 4 & 4 & 6 & 7 & 7 \\ 7 & 7 & 1 & 3 & 3 \\ 7 & 7 & 1 & 3 & 3 \end{bmatrix}$

for $f(0,0) = f(0,0) = 3$

$$G_x = \begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}, \quad G_y = \begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

$G_x = (-3-3-2+4+4+0) = 6$

$G_y = (-3-3-4+2+2+6) = 0$

$R = |G_x| + |G_y| = 6$

for $(0,0) = 2$

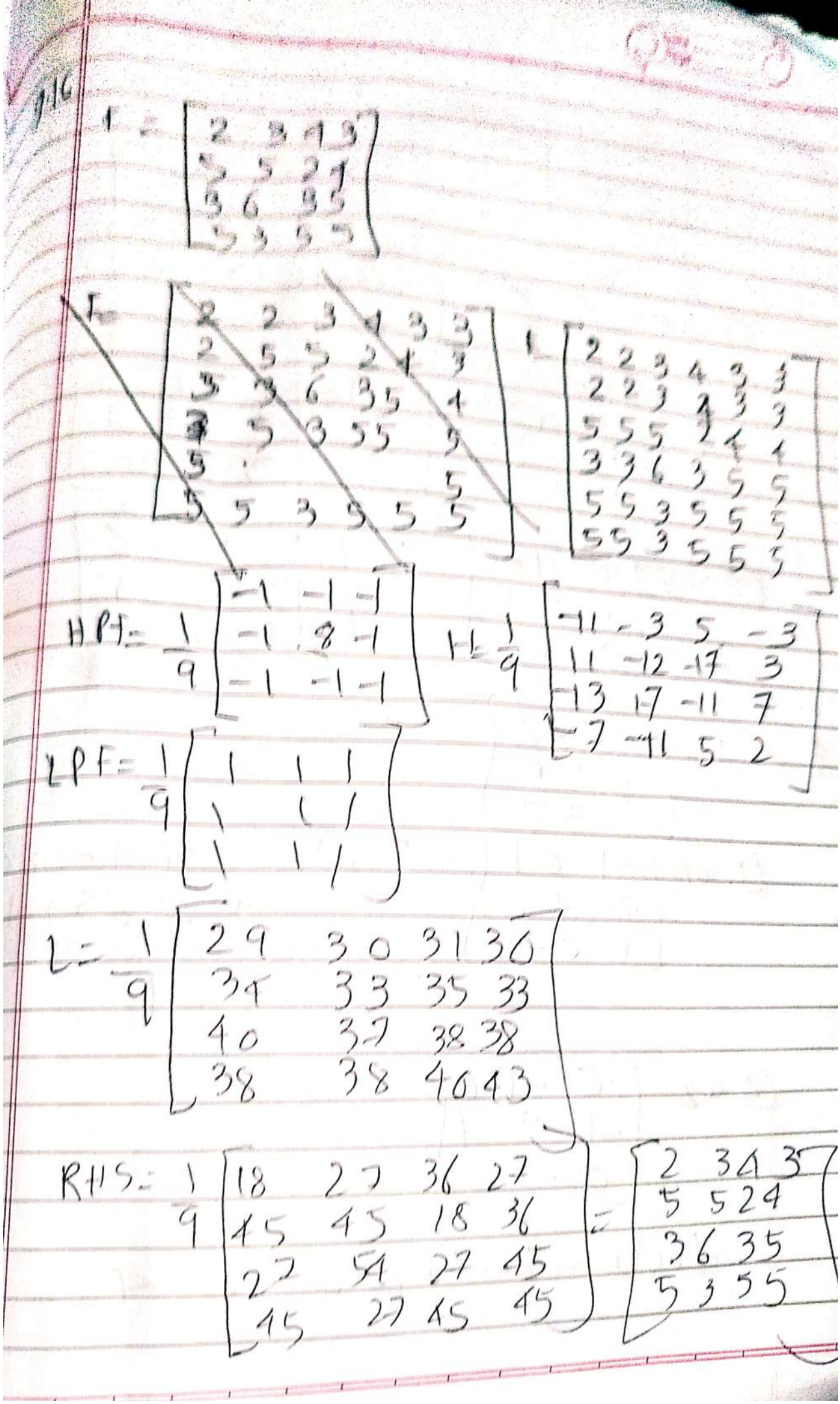
$G_x = -3-2-5+4+6+7 = 7$

$G_y = -3-3-4+5+5-7 = -2$

$R = 14$

$$F = \begin{bmatrix} 6 & 14 & 18 \\ 12 & 2 & 4 \\ 11 & 11 & 18 \end{bmatrix}$$

$$F = \begin{bmatrix} 6 & 14 & 18 \\ 12 & 2 & 4 \\ 11 & 14 & 18 \end{bmatrix}$$



9.17 $F=\begin{bmatrix}4&8&2\\7&5&6\\6&3&7\end{bmatrix}$ $F=\begin{bmatrix}0&0&0&0&0\\0&4&8&2&0\\0&7&5&6&0\\0&6&3&7&0\\0&0&0&0&0\end{bmatrix}$

(1) $\omega_1=\begin{bmatrix}0&0&0\\-1&2&-1\\0&0&0\end{bmatrix}$ $F=\begin{bmatrix}0&10&-4\\9&-3&7\\9&-7&11\end{bmatrix}$

(2) $\omega_2=\begin{bmatrix}0&-1&0\\0&2&0\\0&-1&0\end{bmatrix}$ $F=\begin{bmatrix}1&11&-2\\4&-1&3\\5&1&8\end{bmatrix}$

(3) $\omega_3=\begin{bmatrix}0&-1&0\\-1&4&-1\\0&-1&0\end{bmatrix}$ $F=\begin{bmatrix}1&21&-6\\13&-4&10\\14&-6&19\end{bmatrix}$

9.18 $F=\begin{bmatrix}4&8&2\\7&5&6\\6&3&7\end{bmatrix}$

(1) $\omega_1=\begin{bmatrix}-1&0&-1\\0&4&0\\-1&0&-1\end{bmatrix}$ $f(1,1)=-1\times4+-1\times$
$+4\times5+$
$-7\times$
$=1$

(2) $\omega_2=\begin{bmatrix}0&-1&0\\-1&4&-1\\0&-1&0\end{bmatrix}$

$f(1,1)=-8-7+20-6-3=-4$

(3) $w_3 = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$

$F = -4 - 8 - 2 - 7 - 6 - 6 - 3 - 7 + 40$

$= -3$

(4) $F = \begin{bmatrix} 4 & 8 & 2 \\ 7 & 5 & 6 \\ 6 & 3 & 7 \end{bmatrix}$

Laplacian Mask $= \begin{bmatrix} -1 & -1 & -1 \\ -1 & 8 & -1 \\ -1 & -1 & -1 \end{bmatrix}$

$F = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 4 & 8 & 2 & 0 \\ 0 & 7 & 5 & 6 & 0 \\ 0 & 6 & 3 & 7 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$

Applying filter

$F = \begin{bmatrix} 12 & 40 & -3 \\ 30 & -3 & 23 \\ 33 & -7 & 42 \end{bmatrix}$

$F = \begin{bmatrix} 5 & 12 & 2 \\ 10 & 5 & 9 \\ 10 & 2 & 12 \end{bmatrix}$

Q 21

a] False b] False c] True d] False
e] True f] True g] True
h] False i] True j] True k] True
l] True