Q. 1(a) The laplacian is given by

$$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2}$$

$$\frac{\partial \boldsymbol{f}}{\partial \boldsymbol{x}} = \boldsymbol{f}(\boldsymbol{x}+1) - \boldsymbol{f}(\boldsymbol{x}),$$

$$\frac{\partial \boldsymbol{f}}{\partial \boldsymbol{y}} = \boldsymbol{f}(\boldsymbol{y}+1) - \boldsymbol{f}(\boldsymbol{y}),$$

$$\frac{\partial^2 \boldsymbol{f}}{\partial \boldsymbol{x}^2} = \boldsymbol{f}(\boldsymbol{x}+1) - \boldsymbol{f}(\boldsymbol{x}) - (\boldsymbol{f}(\boldsymbol{x}) - \boldsymbol{f}(\boldsymbol{x}-1)) = \boldsymbol{f}(\boldsymbol{x}+1) - 2\boldsymbol{f}(\boldsymbol{x}) + \boldsymbol{f}(\boldsymbol{x}-1)$$

$$\frac{\partial^2 \boldsymbol{f}}{\partial \boldsymbol{y}^2} = \boldsymbol{f}(\boldsymbol{y}+1) - \boldsymbol{f}(\boldsymbol{y}) - (\boldsymbol{f}(\boldsymbol{y}) - \boldsymbol{f}(\boldsymbol{y}-1)) = \boldsymbol{f}(\boldsymbol{y}+1) - 2\boldsymbol{f}(\boldsymbol{y}) + \boldsymbol{f}(\boldsymbol{y}-1)$$

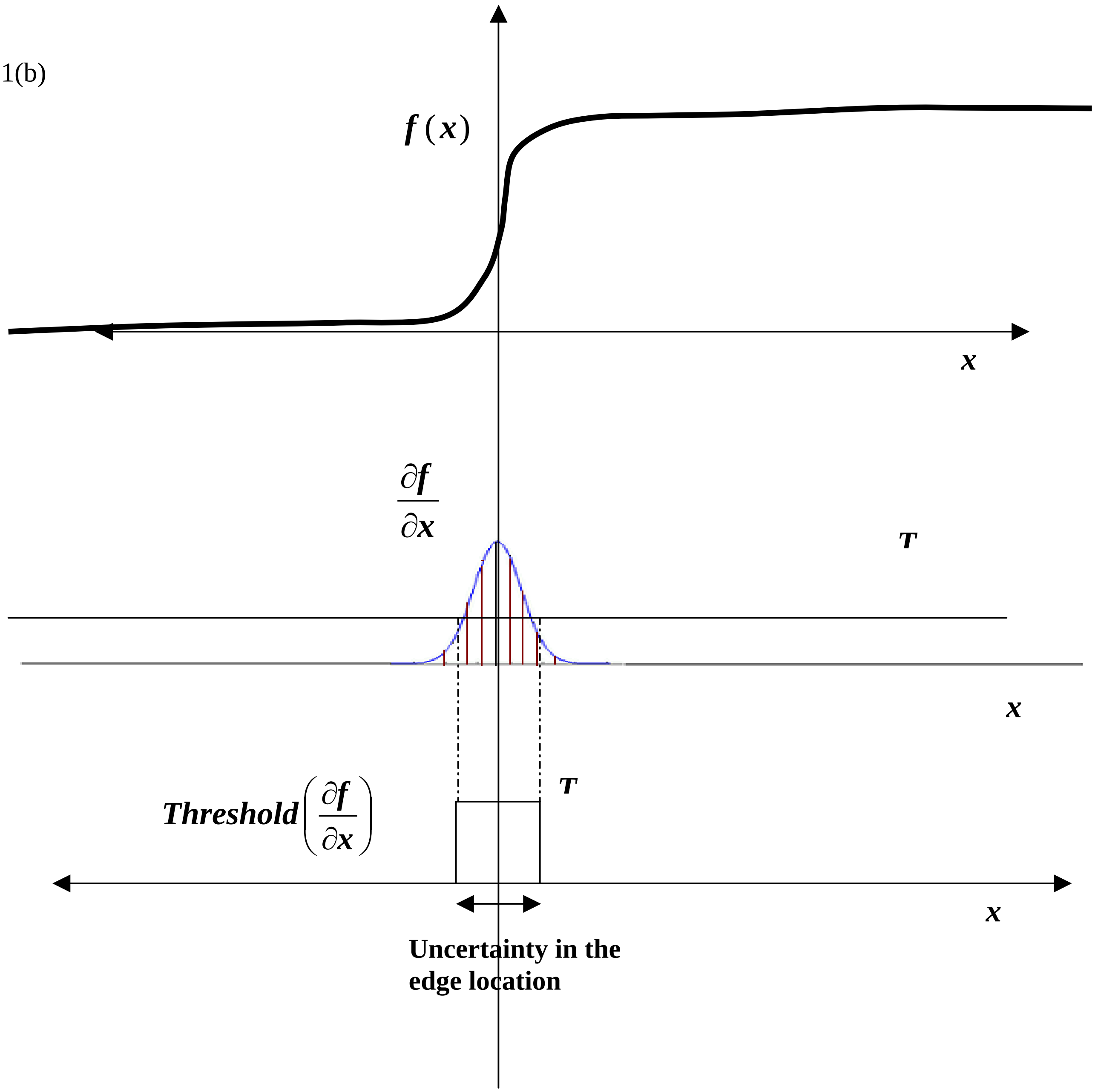
$$\boldsymbol{Laplacian} = \frac{\partial^2 \boldsymbol{f}}{\partial \boldsymbol{x}^2} + \frac{\partial^2 \boldsymbol{f}}{\partial \boldsymbol{y}^2} = \boldsymbol{f}(\boldsymbol{x}+1, \boldsymbol{y}) - 2\boldsymbol{f}(\boldsymbol{x}, \boldsymbol{y}) + \boldsymbol{f}(\boldsymbol{x}-1, \boldsymbol{y}) + \boldsymbol{f}(\boldsymbol{x}, \boldsymbol{y}+1) - 2\boldsymbol{f}(\boldsymbol{x}, \boldsymbol{y}) + \boldsymbol{f}(\boldsymbol{x}, \boldsymbol{y}-1)$$

0	1	0
1	(-2-2)	1
0	1	0

$\Rightarrow$

0	1	0
1	-4	1
0	1	0

Q. 1(b)



$f(x)$
x
$\frac{\partial f}{\partial x}$
T
x
T
$Threshold\left(\frac{\partial f}{\partial x}\right)$
x
Uncertainty in the edge location

Q 2. (a) Assuming padding on both sides we pad the arrays F and G on both sides

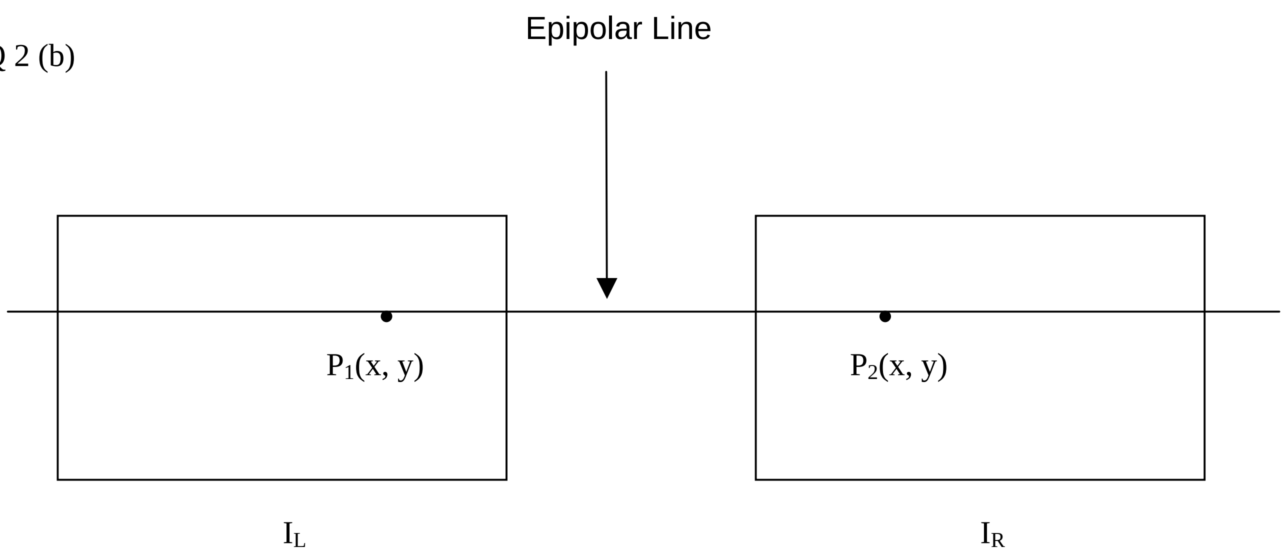
0	0	0	0	0
0	2	5	7	0
0	4	**6**	8	0
0	5	7	9	0
0	0	0	0	0

0	0	0	0	0
0	3	3	3	0
0	3	**3**	3	0
0	3	3	3	0
0	0	0	0	0

Ans:-

6	21	42	36	21
18	51	96	78	45
33	87	159	126	72
27	66	117	90	51
15	36	63	48	27

Q 2 (b)



$$Z = \frac{Bf}{D} \Rightarrow \qquad D = X_L - X_R$$

The correspondence problem is: Given (X_L, YL) on I_l find the corresponding point (X_R, Y_R) on I_R (and vice versa). The search is restricted the Epipolar line.

Different methods to solve the correspondence problem (obtain matching pair of corresponding points) are

- Convolution
- Correlation
- Prototype matching

Q. 3. (a)

$$F(u,v) = \iint f(x,y) e^{-2\pi j(ux+vy)} dx\, dy$$

$$F'(u,v) = \iint f(x-x_0, y-y_0) e^{-2\pi j(ux+vy)} dx\, dy$$

Substituting,

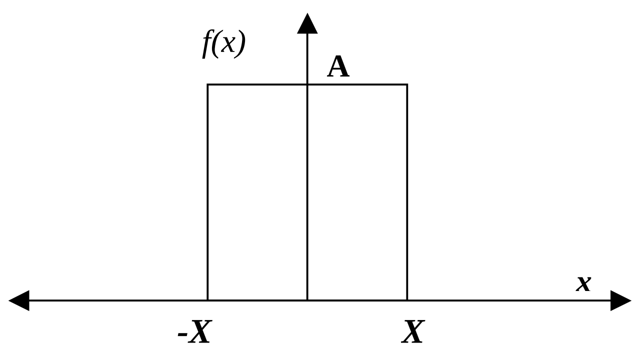
$$x - x_0 = s \ , y - y_0 = t \qquad dx = ds,\ dy = dt$$

$$F'(u,v) = \iint f(s,t) e^{-2\pi j(u(s+x_0)+v(t+y_0))} dx\, dy$$

$$F'(u,v) = e^{-2\pi j u x_0} e^{-2\pi j v y_0} \iint f(s,t) e^{-2\pi j(us+vt))} ds\, dt$$

$$F'(u,v) = e^{-2\pi j(ux_0+vy_0)} F(u,v)$$

Q. 3(b)



$$\boldsymbol{F(w)} = \int_{-X}^{X} \boldsymbol{A e^{-jwt} dt} = \boldsymbol{A} \int_{-X}^{X} \boldsymbol{e^{-jwt} dt} \qquad \mathrm{w} = 2\pi \mathrm{u}$$

$$= \boldsymbol{A}\left[\frac{\boldsymbol{e^{-jwt}}}{-\boldsymbol{jw}}\right]_{-X}^{X} = \frac{\boldsymbol{A}}{-\boldsymbol{jw}}\left[\boldsymbol{e^{-jwX}} - \boldsymbol{e^{jwX}}\right]$$

$$= \frac{2\boldsymbol{A}}{\boldsymbol{w}}\left[\frac{\boldsymbol{e^{jwX}} - \boldsymbol{e^{-jwX}}}{2\boldsymbol{j}}\right] = \frac{2\boldsymbol{A}}{\boldsymbol{w}}\sin(\boldsymbol{wX}) = \frac{\boldsymbol{A}}{\pi\boldsymbol{u}}\sin(2\pi\boldsymbol{uX})$$

$$= 2\boldsymbol{AX}\ \ \mathrm{Sinc(wX)} = \mathrm{2AX\,Sinc}(2\pi\mathrm{uX})$$