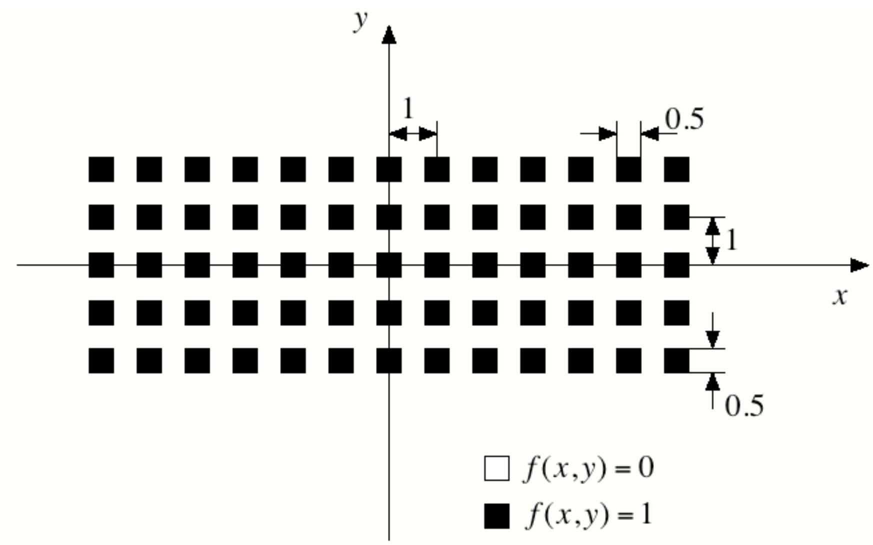
Due Wednesday November 18, 2009
in class or in TA's dropbox on Rhea (zhang253)

ECE 438 **Assignment No. 8** **Fall 2009**

1. For each function given below, do the following:
   i. Sketch $f(x,y)$
   ii. Express $f(x,y)$ in terms of the special functions given in class.
   iii. Find its CSFT $F(u,v)$ using transform pairs and properties.
   iv. Sketch $F(u,v)$ in enough detail to show that you know what it looks like.

   a. $$f(x,y) = \begin{cases} \cos(2\pi(x-y)), & x^2+y^2<4 \\ 0, & \text{else} \end{cases}$$

   b.



2. The 2-D signal $f(x,y) = 1+\cos(2\pi(3x+y))$ is sampled with an ideal sampler at 4 samples/inch to generate the signal
$$f_s(x,y) = \sum_m \sum_n f(0.25m, 0.25n)\delta(x-0.25m, y-0.25n)$$
This signal is then convolved with $\mathrm{sinc}(4x,4y)$ to yield the reconstructed signal $f_r(x,y)$.
   a. Sketch $f(x,y)$ showing a top view of the *x-y* plane in which the points where $f(x,y)=1$ are clearly labeled.
   b. Find a simple expression for $f_r(x,y)$.
   c. Sketch $f_r(x,y)$ showing a top view of the *x-y* plane in which the points where $f_r(x,y)=1$ are clearly labeled.

3. Consider a 3×3 FIR filter with coefficients $h[m,n]$

	m		
n	-1	0	1
1	-0.125	0.5	-0.125
0	-0.25	1.0	-0.25
-1	-0.125	0.5	-0.125

a. Find a difference equation that can be used to implement this filter.

b. Find the output image that results when this filter is applied to the input image shown below:

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

c. Find a simple expression for the frequency response (DSFT) $H(\mu,\nu)$ of this filter.

d. Plot $H(\mu,\nu)$ along the μ axis $(\nu = 0)$, along the ν axis $(\mu = 0)$, along the line $\mu = \nu$, and along the line $\mu = -\nu$.

e. Discuss the relation between your answer to part b. and the filter frequency response.