EE 637 Homework #1
Spring 1998

1. Prove the following:

   i) The convolution property of the CTFT.

   ii) The separability property of the CSFT.

2. Let $s(n) = x(Tn)$ where $x(t)$ is a continuous time signal and $s(n)$ is its sampled version. Derive the relationship between $X(f)$ and $S(e^{j\omega})$ from the definitions of the DTFT and CTFT.

3. For each of the following D-T signals x(n):

   i) Compute its DTFT using only the transform equation, the known properties of the DTFT, and the result of problem 2 above.

   ii) Sketch $x(n)$ and $X(e^{j\omega})$.

   a) $x(n) = 1$

   b) $x(n) = \text{pulse}_5(n)$

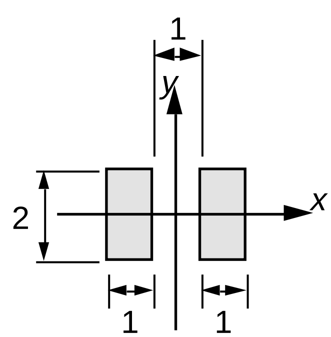
   c) $x(n) = \text{sinc}(n/10)$

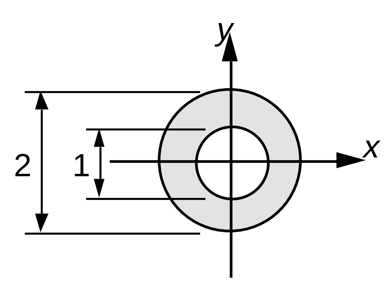
4. For each of the two functions given below, do the following:

   i) Express $f(x, y)$ in terms of special functions given in class.

   ii) Find its CSFT $F(u, v)$ using transform pairs and properties.

   iii) Sketch $F(u, v)$ in enough detail to show that you know what it looks like. Assume that $f(x, y) = 1$ in shaded regions and $f(x, y) = 0$ elsewhere.





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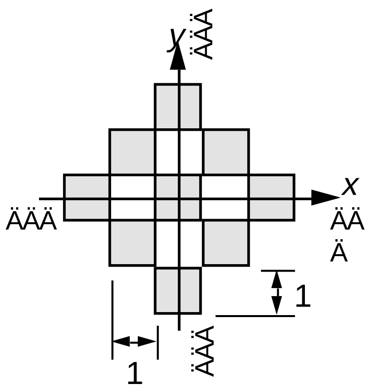

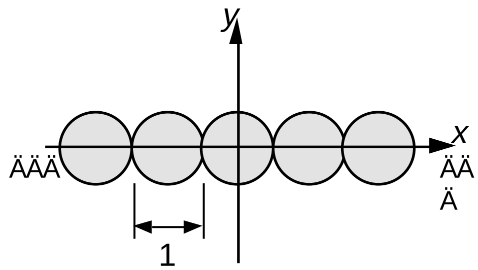

6. Compute the DSFT $X(e^{j\mu}, e^{j\nu})$ of the following functions

a) $x(m, n) = a^n u(n)\delta(m)$

b) $x(m, n) = a^{|n|+|m|}u(m)$

7. Let $y(n)$ be a filtered version of $x(n)$ where the filter's impulse response is given by $h(n)$. Futhermore, let $X = [x(0), \cdots, x(N-1)]^t$ and $Y = [y(0), \cdots, y(N-1)]^t$ and assume that $x(n) = 0$ for $n < 0$ and $n \geq N$.

a) Give a formula for $y(n)$ in terms of $x(n)$ and $h(n)$.

b) Find a matrix $\mathbf{A}$ so that $Y = \mathbf{A}X$. Give a precise expression for the elements of $\mathbf{A}$.

c) Write out the matrix $\mathbf{A}$ for $N = 5$.

d) Show that $\mathbf{A}$ is a Toeplitz matrix.