

Fourier Optics EOP 513
First Exam (in-class)
9 June 2003

1. Given the function $f(x) = \text{step}(x)\text{tri}(x)$, plot the following (3 points each)

(a) $f(x)$

(b) $f(x - 5)$

(c) $f(x/2)$

(d) $f(x - 1) - f(1 - x)$

2. Find the convolution $f(x) * f(x)$ for $f(x) = \text{step}(x)\text{tri}(x)$ (10 points)

3. Define (3 points each)

(a) Fresnel number

(b) Huygen's wavelets

(c) Fraunhofer approximation

(d) Optical wavefront

(e) Cornu spiral

4. What is the value of the Fresnel number in the Fraunhofer limit? (2 points)
5. What value of the Fresnel number separates near and far fields? (2 points)
6. If $g(x) = f(x) * h(x)$, what is $f(x - 3) * h(x + 2)$? (3 points)
7. Describe the optical phenomenon of diffraction. What role does convolution play?(5 points)
8. Find the following Fourier transforms (2 points each)
 - (a) $\delta(x)$
 - (b) $\text{rect}(x)$
 - (c) $\text{gaus}(x)$
 - (d) $\text{sech}(\pi x)$
 - (e) $\cos(2\pi\xi_0 x)$
9. Define the function $\text{comb}(x)$ and describe how it is used to define the discrete sampling of a function $f(x)$. (3 points)
10. Describe how the δ -function is obtained as the limit of a sequence of functions. (3 points)

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11. Given the functions

$$\begin{aligned}f(x) &= \text{step}(x)\text{tri}(x) \\g(x) &= \text{gaus}(x + 2) - \text{gaus}(x - 2)\end{aligned}$$

find the plot the following (5 points each)

- (a) $f(x) * f(x)$.
- (b) $g(x) * g(x)$.
- (c) $f(x) * g(x)$.

12. Plot the two-dimensional function $g(x)g(y)$ in three different ways. (10 points)

13. Given $f(x) = \text{gaus}(x + d) - \text{gaus}(x - d)$

- (a) Find the analytic Fourier Transform of $f(x)$. (5 points)
- (b) Use Matlab to calculate and plot the function $f(x)$ with $d=2$ and either the real or imaginary part of its Fourier Transform (as appropriate). (5 points)