Fourier Optics EOP 513
First Exam (in-class)
20 June 2007

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

   (a) $f(x)$

   (b) $f(x+3)$

   (c) $f(x/2)$

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

2. If $g(x) = f(x) * h(x)$, what is $f(x-5) * h(x+3)$? (3 points)

3. State the following Fourier transforms (2 points each)

   (a) $\delta(x)$

   (b) $\text{rect}(x)$

   (c) $\text{gaus}(x)$

   (d) $\text{tri}(x)$

   (e) $\cos(2\pi\xi_o x)$

4. What Fresnel number separates near and far fields? (2 points)

5. What Fresnel number corresponds to the Fraunhoffer limit? (2 points)

6. What is $\delta(x) * \delta(x)$?. (1 point).

7. Define (3 points each)

   (a) Fresnel appoximation

   (b) Huygen's wavelets

   (c) Obliquity factor

   (d) Optical wavefront

   (e) Cornu spiral

8. Give the name (if defined) and explain the significance of the following groups of constants and the circumstances in which they arise.

   (a) $\sqrt{\lambda z}$

   (b) $\frac{w^2}{\lambda z}$

   (c) $\frac{\lambda}{w}$

   (d) $\frac{\lambda z}{w}$

   (e) $\frac{w^2}{\lambda}$

   where λ is the wavelength, w is the half-width of a slit or aperture, and z is a propagation distance. (10 points)

9. Given a sharp edge diffracting light of wavelength 0.633 μm. What is the approximate separation of fringes in the diffraction pattern at a distance of 4 meters. (5 points)

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10. Given the functions

$$\begin{aligned} f(x) &= \text{step}(-x)\text{tri}(x) \\ g(x) &= (2x^2 - 1)\text{gaus}(x) \end{aligned}$$

find the plot the following (5 points each)

(a) $f(x) * f(x)$.

(b) $g(x) * g(x)$.

(c) $f(x) * g(x)$.

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

12. Given $f(x) = 2x \text{ gaus}(x)$

(a) Find the analytic Fourier Transform of $f(x)$. (5 points)

(b) Use Matlab to calculate and plot the function $f(x)$ and either the real or imaginary part of its Fourier Transform (as appropriate). (5 points)

13. Given the function $p(x)$ defined below, calculate and plot the function and its Fourier transform. (5 points)

$p(x) = 1$ for $|x| < 0.8$

$p(x) = 1 - (5|x| - 4)^2$ for $0.8 \leq |x| \leq 1$, and

$p(x) = 0$ otherwise.