Problem Set 1
Physics 266 Second Semester, AY 2024-2025
10 points per number Due: 30 May 2025 (Friday)

1. Consider *rect(x,y)* with its center located at the origin (0, 0) of the x-y plane. The sides of *rect(x,y)* are *a* and *b* respectively. Its roof is: *rect(x,y)* = 1.0.

Plot its corresponding two-dimensional Fourier transform when: (a) *a* = *b* = 10 mm, (b) *a* = *b/100* = 1 mm, (c) *a/100* = *b* = 1 mm. The 2D Fourier plots must use the correct units and satisfy Parseval's theorem (conservation of energy).

Explain the similarities and differences between plots 1(a), 1(b), and 1(c).

2. Consider *rect(x,y)* with its center located at the origin (0, 0) of the x-y plane. The sides of *rect(x,y)* are *a* and *b* respectively. Its roof *rect(x,y)* value decreases from *rect(0,0)* = maximum to *rect*(sides) = 0. The volumes of *rect(x,y)* in Q1 and Q2 are equal.

Plot its Fourier transform when: (a) *a* = *b* = 10 mm, (b) *a* = *b/100* = 1 mm, (c) *a/100* = *b* = 1 mm

Explain the similarities and differences between plots 2(a), 2(b), and 2(c).

3. Explain differences between plots 1(a) and 2(a), 1(b) and 2(b), and 1(c) and 2(c).

4. Consider a circular function *circ(r)* that is centered on the origin of the x-y plane. The radius of the circular function is R, and its roof (height) is uniformly flat at unity value.

Plot its Fourier transform when: (a) *R* = 10 mm, (b) *R* = 1 mm, (c) *R = 100 mm*

5. Consider a circular function *circ(r)* that is centered on the origin of the x-y plane. The radius of the circular function is R. Its height is uniformly decreasing from *circ(r=0)* = max to *circ(r = R)* = 0 with the volume of *circ(r)* maintained for both Q4 and Q5.

Plot its Fourier transform when: (a) *R* = 10 mm, (b) *R* = 1 mm, (c) *R = 100 mm*

6. Consider a circular function *circ(r)* that is centered on the origin of the x-y plane. The radius of the circular function is R. Its height obeys the Gaussian distribution such that: *circ(r=0)* = max and circ(r = R) = 0.001, with the volume of *circ(r)* maintained for both cases 4, 5 and 6.

Plot its Fourier transform when: (a) *R* = 10 mm, (b) *R* = 1 mm, (c) *R = 100 mm*

7. Explain differences in the Fourier plots: 4(a) vs. 5(a) vs. 6(a), 4(b) vs. 5(b) vs. 6(b) and 4(c) vs 5(c) vs 6(c).

END