

## 1 Fourier Transform of Cosine and Sine

- (a) Find the Fourier transforms of  $f(x) = \cos kx$  and  $g(x) = \sin kx$ .
- (b) Find the Fourier transform of  $g(x)$  using the formula for the Fourier transform of a derivative and your result for the Fourier transform of  $f(x)$ . Compare with your previous answer.
- (c) In quantum mechanics, the Fourier transform is the set of coefficients in the expansion of a quantum state in terms of plane waves, i.e. the function  $\tilde{f}(k)$  is a continuous histogram of how much each functions  $e^{ikx}$  contributes to the quantum state. What does the Fourier transform of the function  $\cos kx$  tell you about which plane waves make up this quantum state? Write a sentence or two about how this makes sense.