

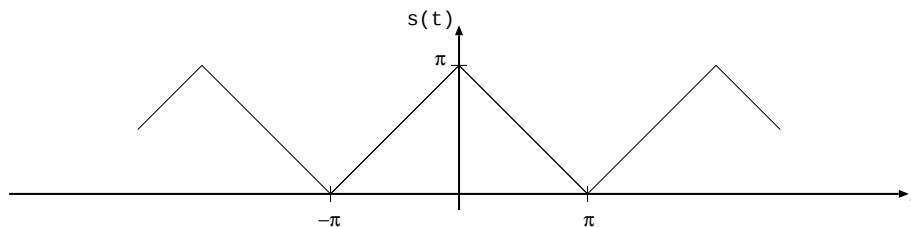
Digital Processing of Speech and Image Signals

3. Exercise

Submission of the solutions: 13. 11. 2006 at the beginning of the lecture

Task 3.1 Can the function $\text{rect}(t)$ be the autocorrelation function of a real function $h(t)$? Reason based on the power spectrum. (2 P.)

Task 3.2 Given the following periodic signal $s(t)$



- Describe the signal as a convolution of a comb function with another function.
- Calculate the fourier integral of this convolution.
Hint:
Lecture script, p. 39
- Calculate the Fourier series. Check that the resulting Fourier transform is the same as in exercise (b).
- Sketch the spectrum of the function.

Task 3.3

A quantity is said to be subject to exponential decay if it decreases at a rate proportional to its value. Symbolically, this can be written as the differential equation $y'(t) = -\alpha y(t)$. Consider a factory which adds up a constant amount $x(t) = \beta$ to the decaying material:

$$y'(t) = -\alpha y(t) + x(t)$$

- (a) Calculate the Fourier integral $Y(\omega)$ of this system. Hint: Use the properties of the Fourier transform as presented in the lecture.
- (b) Apply the inverse Fourier-transform to $Y(\omega)$. Interpret the resulting function $y(t)$.



Paul Adrien Maurice Dirac (1902-1984) was a British theoretical physicist and a founder of the field of quantum physics. He held the Lucasian Professorship of Mathematics at the University of Cambridge. Among other key discoveries, he formulated the so-called *Dirac equation*, which describes the behavior of fermions and which led to the prediction of the existence of antimatter. Dirac shared the Nobel Prize in physics for 1933 with Erwin Schrödinger, for the discovery of new productive forms of atomic theory.

Anecdotally, when Oppenheimer was working at Göttingen, Dirac supposedly came to him one day and said: *Oppenheimer, they tell me you are writing poetry. I do not see how a man can work on the frontiers of physics and write poetry at the same time. They are in opposition. In science you want to say something that nobody knew before, in words which everyone can understand. In poetry you are bound to say... something that everybody knows already in words that nobody can understand.*

Source: <http://www.wikipedia.com>