EE 102 # Homework #6 **Fall 2001**

Professor Paganini **Due Wednesday 11/21/01**

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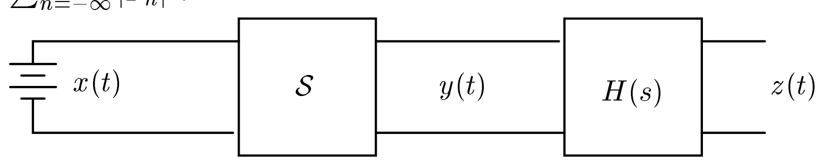
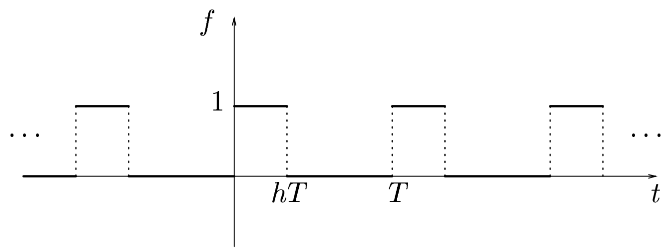
1. Consider the function $f(t)$ from Homework # 5, problem 4; you already found the Fourier series $f(t) = \sum_{n=-\infty}^{\infty} F_n e^{in\omega_0 t}$.

   (a) Now find the sine-cosine Fourier series representation.

   (b) Compute $\sum_{n=-\infty}^{\infty} |F_n|^2$.

2. 

   The circuit in the above figure is used for DC to DC conversion. The first stage $\mathcal{S}$ is a switching system, that periodically alternates between the "ON" state where the output is equal to the input, and the "OFF" state where the output is zero (should be familiar from the midterm...). More precisely, we have $y(t) = x(t)f(t)$, where $f(t)$ is the function in the figure, that alternates between 0 and 1. The constant h (called the "duty cycle") satisfies $0 < h < 1$.



   a) Assume the DC input $x(t) \equiv V_0$ for all time. Find the Fourier series representation for $y(t)$.

   b) Find the relation between the AC power $P_{AC}(y)$ and the DC power $P_{DC}(y)$.

   c) We now consider the filter $H(s) = \frac{1}{1+\tau s}$ in cascade. How does the DC component of $z(t)$ vary with h?

   d) Set $h = \frac{1}{2}$, and take $\tau = 3\,T$. Estimate (e.g. giving a reasonably tight bound) the ratio between the AC power $P_{AC}(z)$ and the DC power $P_{DC}(z)$.

3. Find the Fourier series expansion of $f(t) = \sin(t)\sin(2t)$, and express the answer in sine-cosine form. *Hint:* no need to compute any integrals! Also find $\overline{\epsilon_1^2}$, the mean-square error when approximating $f(t)$ up to the first harmonic.