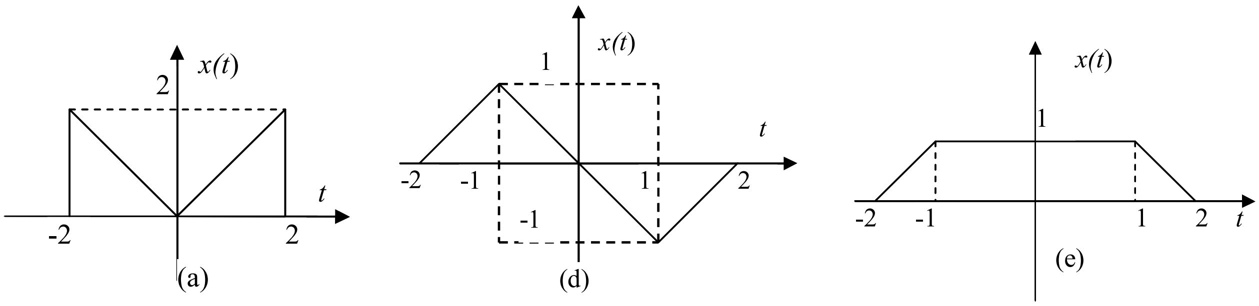
Assignment #2

Due: Jan. 31, 11:30am, MNO C211 (the tutorial). Hard copies only. Late/electronic/email submissions will **not** be accepted.

1) Find the Fourier transform of the Dirac delta function $\delta(t)$ by considering it as the following limit of functions: (a) $\delta(t) = \lim_{\varepsilon\to 0}\frac{1}{\varepsilon}\Pi(t/\varepsilon)$; (b) $\delta(t) = \lim_{\varepsilon\to 0}\frac{1}{\varepsilon}\mathrm{sinc}(t/\varepsilon)$. Assume that in these cases the Fourier transform of a limit of functions is the limit of the Fourier transform of the functions.

2) Determine the Fourier transform of the following signals:



3) Prove the convolution property of the Fourier transform.

4) Use the convolution theorem to show that $\mathrm{sinc}(t) * \mathrm{sinc}(t) = \mathrm{sinc}(t)$. Can you prove this directly?

5) Let x(t) be an arbitrary signal and define $x_a(t) = \sum_{n=-\infty}^{\infty} x(t - nT_s)$. A) Show that $x_a(t)$ is a periodic signal. B) How can you write $x_a(t)$ in terms of x(t) and $x_a(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$? C) Find the Fourier transform of $x_a(t)$ in terms of the Fourier transform of x(t).

6) Classify the following signals into energy-type, power-type and neither energy-type nor power-type signals. For energy-type and power-type signals, find the energy or the power content of the signal:
1) $x_1(t) = e^{-t}\cos t \cdot u(t)$; 2) $x_2(t) = e^{-2t}\cos t$; 3) $x_3(t) = \mathrm{sinc}(t)$; 4) $x_4(t) = A\cos 2\pi f_1 t + B\sin 2\pi f_2 t$.

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All sketching of functions is to be done by hand. No computers/graphing calculators may be used.

Please include in your solutions all the intermediate results and their numerical values (if applicable). **Detailed solutions with explanations are required**, not just the final answers/equations; **all symbols used must be defined**, including units used, if applicable (e.g. f = frequency [Hz]). Missing explanations, symbol definitions/units will be penalized. Your answers should demonstrate the full extent of your knowledge and the latter will determine your marks.

Plagiarism (i.e. "cut-and-paste" from a student to a student, other forms of "borrowing" the material for the assignment) is absolutely unacceptable and will be penalized. Each student is expected to submit his own solutions. If two (or more) identical or almost identical sets of solutions are found, each student involved receives 0 (zero) for that particular assignment. If this happens twice, the students involved receive 0 (zero) for the entire assignment component of the course in the marking scheme and the case will be send to the Dean's office for further investigation.

Please read appropriate chapters of the textbook first, study all the examples, attempt to do them with the closed book. Remember the learning efficiency pyramid!

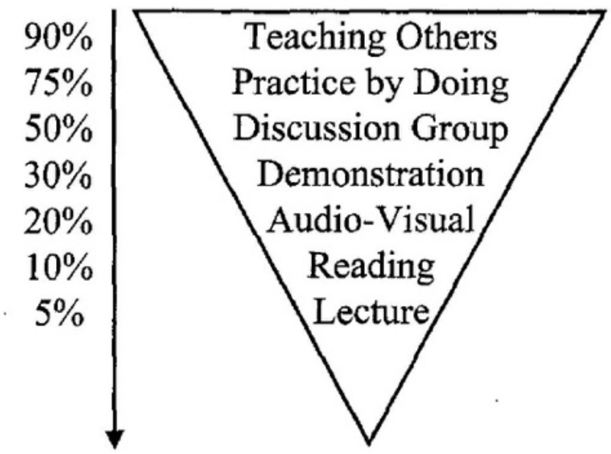

Figure 1. The Learning Pyramid, adapted from David Sousa, *How the Brain Learns*, Reston, VA, The National Association of Secondary School Principals, 1995, ISBN 0-88210-301-6.