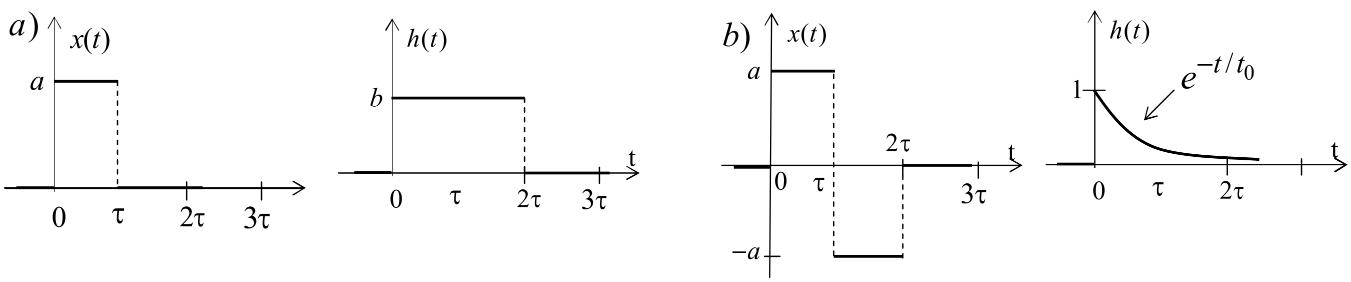
Assignment #1

Due: Jan. 17, 11:30am, MNO C211 (the tutorial). Late/electronic/email submissions will **not** be accepted.

This assignment is a refresher of ELG3125. Please consult your notes/textbooks for that course. Our current textbook also provides a wealth of information.

1) Sketch on the same graph the following functions (see Note 1 !) and indicate their values at the principal points: $|\sin x|$, $\sin\left(x+\frac{\pi}{4}\right)$, $\sin^{1022} x$

2) Find graphically the convolution of the functions x(t) and h(t) and sketch the result:



3) Noting that $\mathrm{Re}[z_1 z_2] = \mathrm{Re}[z_1]\mathrm{Re}[z_2] - \mathrm{Im}[z_1]\mathrm{Im}[z_2]$, how can $\cos(\alpha+\beta) = \mathrm{Re}\left[e^{j(\alpha+\beta)}\right]$ be expressed? Give the final answer in a simple form, without complex-valued functions.

4) A system input-output relation is expressed by the following operator: $y(t) = \mathbf{L}[x(t)] = x^*(t)$, where * means complex conjugate. Is this system: (a) linear, (b) time-invariant, (c) casual, (d) stable?

5) Find the Fourier series expansion for the following signals below. First sketch each signal. Definition of $\Lambda(t)$ is given in the course textbook.

   a) $x(t) = \sum_{n=-\infty}^{\infty} \Lambda(t-n)$; b) $x(t) = \cos t + \cos(1.5t)$; c) $x(t) = \sum_{n=-\infty}^{\infty} (-1)^n \delta(t-nT)$; d) $x(t) = |\cos 2\pi f_0 t|$

6) Let x_n and y_n represent the Fourier Series coefficients of x(t) and y(t), respectively. Assuming the period of x(t) is T_0, express y_n in terms of x_n in each of the following cases (give a detailed derivation for each case):

   a) $y(t) = x(t-t_0)$; b) $y(t) = x(t)e^{j2\pi f_0 t}$; c) $y(t) = x(at), a \neq 0$; d) $y(t) = \frac{d}{dt}x(t)$.

7) Show that for all periodic physical signals that have finite power, the coefficients of the Fourier series expansion c_n tend to zero as $n \to \infty$.

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All sketching of functions is to be done by hand. No graphing calculators or computers 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!

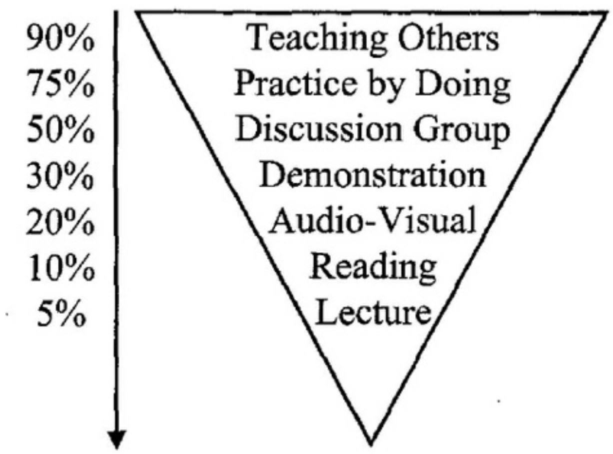

Figure 1. The Learning Pyramid, adapted from David Sousa, *How the Brain Learns*, Reston, VA, The National Association of Secondary School Principals, 1995, ISBN 0-88210-301-6.