Australian National University
Research School of Engineering
College of Engineering and Computer Science

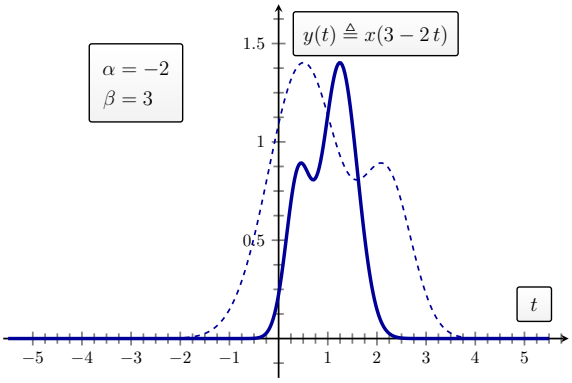
ENGN2228 Signal Processing

HOMEWORK 2

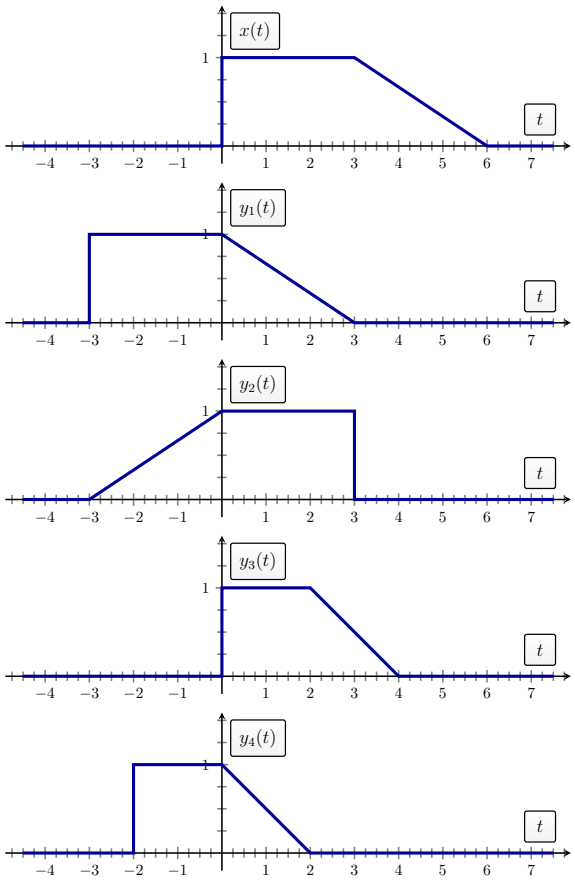
Homework 2-1

Review the independent variable affine transformation examples on lecture slides 50 and 52, shown below.

(a) Confirm the solid blue curve in the figure (blow) is indeed $y(t) = x(3 - 2t)$ where $x(t)$ is the dashed curve.



(b) Express each of $y_1(t)$, $y_2(t)$, $y_3(t)$, $y_4(t)$ in terms of $x(t)$ (shown to the right).



Homework 2-2

Review phasors, see phasors on wikipedia and looks at phasor diagrams for one sinusoid and phasor diagram for sum of two sinusoids, where this only works because the sinusoids are the same frequency.

Homework 2-3

(Hard) Movies like two sinusoids show what happens when there is the sum of two sinusoids at the same frequency. The real part of the rotating phasor maps out a sinusoid. Using the phasor ideas, suppose there is the sum of two sinusoids at different frequencies, for example at ω and 3ω such as

$$\cos(\omega t) + \frac{1}{9}\cos(3\omega t)$$

What modification happens to the phasor picture?

Homework 2-4

Lecture slides 55 and 56 show that adding two periodic signals of different periods can give you an output signal that is periodic:

(a) When does this occur in general?

(b) Assuming all periods under consideration are integer-valued (like 7 or 11 and not 4/5 nor $\sqrt{2}$), answer the following. If the output is periodic what is the relationship of the output period to the two input periods?

(c) Repeat the previous part in the case when the periods are not integer-valued. (For example, suppose $T_1 = 4098\sqrt{2}$ and $T_2 = 18879\sqrt{2}$.)

Homework 2-5

Review the type of calculation shown on lecture slide 70, repeated here

$$\begin{aligned} A\cos(\omega_0 t + \phi) &= \frac{A}{2}e^{j\phi}e^{j\omega_0 t} + \frac{A}{2}e^{-j\phi}e^{-j\omega_0 t} \\ &= A\,\Re\{e^{j(\omega_0 t+\phi)}\} \end{aligned}$$

and

$$A\sin(\omega_0 t + \phi) = A\,\Im\{e^{j(\omega_0 t+\phi)}\},$$

which needs the Euler identity (here A is real-valued).

Homework 2-6

Roger Federer and Leonhard Euler were both born in Basel Switzerland but they never meet. Why?

Homework 2-7

CT signal $x(t) = e^{j\omega t}$ is periodic for any choice of ω.

(a) True or false?

(b) What is its fundamental period when $\omega = 4$?

(c) What is its fundamental period when $\omega = 19\pi$?

Homework 2-8

DT signal $x[n] = e^{j\omega n}$ is not periodic for every choice of ω.

(a) True or false?

(b) Is it periodic when $\omega = 4$?

(c) Is it periodic when $\omega = 19\pi$?

(d) How does the DT signal $x[n] = e^{j19\pi n}$ differ from $x[n] = e^{j\pi n}$?

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