## Theory Assignment 1

## Answer in no more than 10 pages total Minimum 10pt font size

## August 14, 2015

- 1. (Complex arithmetic) With  $j = \sqrt{-1}$  find the real part, the imaginary part, the complex amplitude, and the complex argument in radians of the following complex numbers.
  - (a)  $e^{j\pi}$
  - (b)  $(1+\sqrt{3}j)^2$
  - (c)  $\frac{e^{j\pi/4}}{1-j}$
  - (d)  $2\sin(j)$

All answers must be written as an exact rational expression perhaps involving square roots and the transcendental numbers  $\pi$  and e. Answers correct to only a finite number of decimal places are not acceptable. Answers involving functions such as sin, cos, tan and their inverses are also not acceptable. Draw/mark each number on the complex plane.

- 2. (**Properties of signals**) Plot each of the following signals and show whether they are: bounded, periodic, right sided, left sided, of finite support, absolutely integrable, square integrable.
  - (a)  $u(t+1)e^{-t}$  where u(t) is the step function
  - (b)  $\sin(\pi t/4) + \cos(\pi t/3)$
  - (c)  $\cos(t)\cos(\pi t)$
  - (d)  $\Pi(t-\frac{1}{2})t^{-1/3}$  where  $\Pi(t)$  is the rectangle pulse
- 3. (Spaces of signals) Show that the set of signals x such that x(t) = 0 for all t < 0 is a linear space, but not a shift-invariant space.
- 4. (**Properties of systems**) State whether each of the following systems are: causal, linear, time invariant, stable, regular. Plot the impulse and step response of the systems whenever they exist.
  - (a) Hx(t) = 3x(t-5) + x(t+1)
  - (b)  $Hx(t) = e^{-|x(t)|}$
  - (c) Hx(t) = t
  - (d)  $Hx(t) = \int_0^1 \sin(\pi \tau) x(t+\tau) d\tau$