EC204: Networks & Systems
Problem Set 1

1. For the signal $x(t)$ illustrated in Fig. 1, sketch (a) $x(t-4)$, (b) $x(t/1.5)$, (c) $x(-t)$, (d) $x(2t-4)$, and (e) $x(2-t)$.

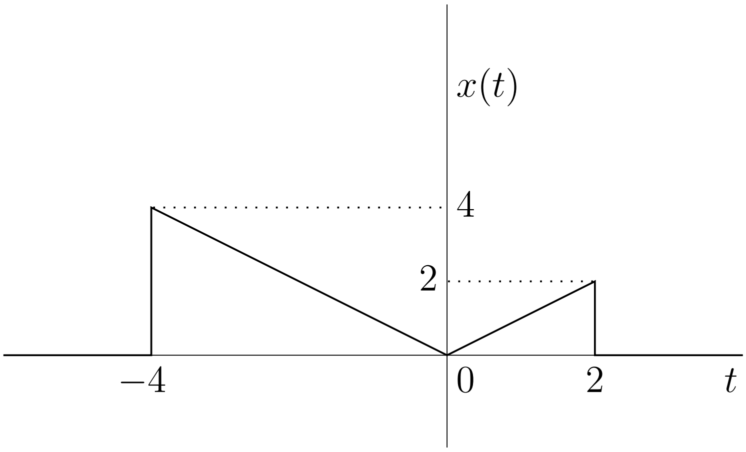


Figure 1:

2. Consider the signal $y(t) = (1/5)x(-2t-3)$ shown in Fig. 2. Determine and carefully sketch the original signal $x(t)$. Determine and carefully sketch $y_o(t)$, the odd portion of $y(t)$.

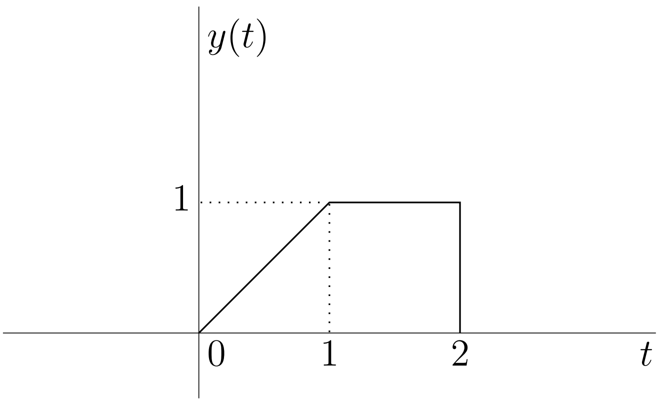


Figure 2:

3. Identify the complex frequencies in the following signals: (a) $\cos 3t$, (b) $e^{-3t}\cos 3t$, (c) $e^{2t}\cos 3t$, (d) e^{-2t}, (e) e^{2t}, and (f) 5.

4. For the systems described by the following equations, with the input $x(t)$ (or $x[n]$) and output $y(t)$ (or $y[n]$), determine which of the systems are linear and which are nonlinear. Also determine which of the systems are time-invariant and which are time-varying.

   (a) $y(t) = \int_{-5}^{5} x(\tau)d\tau$

   (b) $y(t) = tx(t-2)$

   (c) $3y(t) + 2 = x(t)$

   (d) $(t^2+1)\dfrac{dy(t)}{dt} + 2ty(t) = x(t)$

   (e) $y[n] = \cos(n\omega)x[n]$

   (f) $y[n+1] + y^2[n] = 2x[n+1] - x[n]$

   (g) $2\dfrac{d^2y(t)}{dt^2} + 2y(t)\dfrac{dy(t)}{dt} + 4y(t) = 2\dfrac{dx(t)}{dt} + x(t)$

5. A system is specified by its input-output relationship as

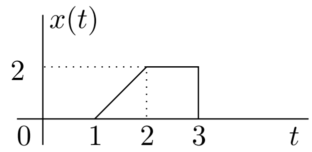
$$y(t) = \frac{x^2(t)}{dx/dt}.$$

   Show that the system satisfies the homogeneity property but not the additivity property.

6. In checking the linearity of a system, it is important to remember that the system must satisfy both the additivity and homogeneity properties and that the signals, as well as any scaling constants, are allowed to be complex. Show that a system with the input $x(t)$ and the output $y(t)$ related by $y(t) = Re\{x(t)\}$ satisfies the additivity property but violates the homogeneity property.

7. A system with input $x(t)$ and output $y(t)$ is characterised by the input-output relationship $y(t) = x(2t-4)$.

   (a) Sketch the output $y(t)$ if $x(t)$ is as shown below.



   (b) Determine if the system is (i) linear/nonlinear, (ii) time-invariant/time-variant, and (iii) causal/non-causal.