EE-3032, HW-0

Dr. Durant, Fall 2019

This assignment is due at the ***beginning of the Monday class*** in week 2. This assignment contains some review from previous classes and some new material. Please ask for help if needed. Please note that I do allow students to work together, but each student must clearly develop their own solution. Other professors have different policies.

Do all work by hand (you can check with calculator or MATLAB).

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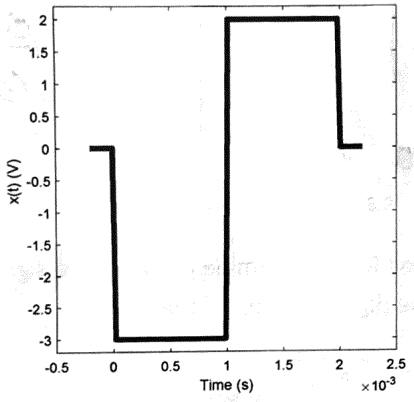
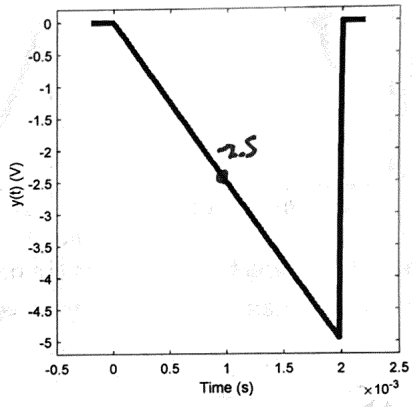
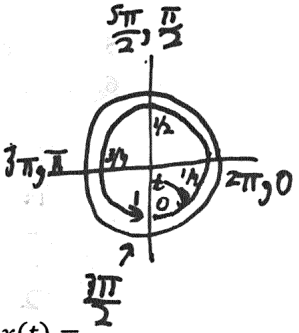
1. The functions $x(t)$ and $y(t)$ are plotted below. Plot $x^2(t)$, $y^2(t)$, and the product function $y(t)x(t)$ over the interval $0 \leq t \leq 2ms$. Clearly label all axes and units on the axis.

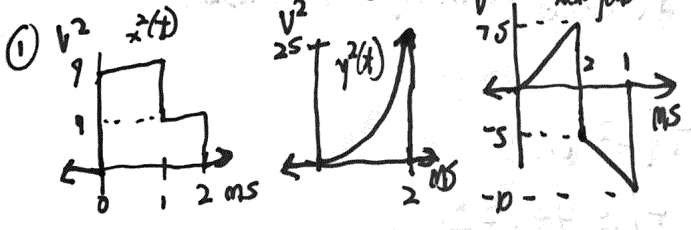






2. Write a simplified expression for $x(t) = \text{Re}\{e^{j(2\pi t + 3\pi/2)}\}$ and evaluate it for $t = 0, 0.25, 0.5, 0.75, 1$.

3. Write an expression for the complex conjugate of the function $f(t) = x(t)y(t)$, where $x(t) = e^{-j100t}$ and $y(t) = \frac{1}{3}t + \frac{\sqrt{3}}{2}j$.

① 

② Euler's Formula: $x(t) = \cos\left(2\pi t + \frac{3\pi}{2}\right)$

t	$2\pi t + 3\pi/2$	$\sin(\cdot)$	$\cos(\cdot)$
0	$\frac{3\pi}{2}$	-1	0
1/4	2π	0	1
1/2	$\frac{5\pi}{2} = (2+\frac{1}{2})\pi$	1	0
3/4	3π	0	-1
1	$\frac{7\pi}{2} = (3+\frac{1}{2})\pi$	-1	0

ANSWER

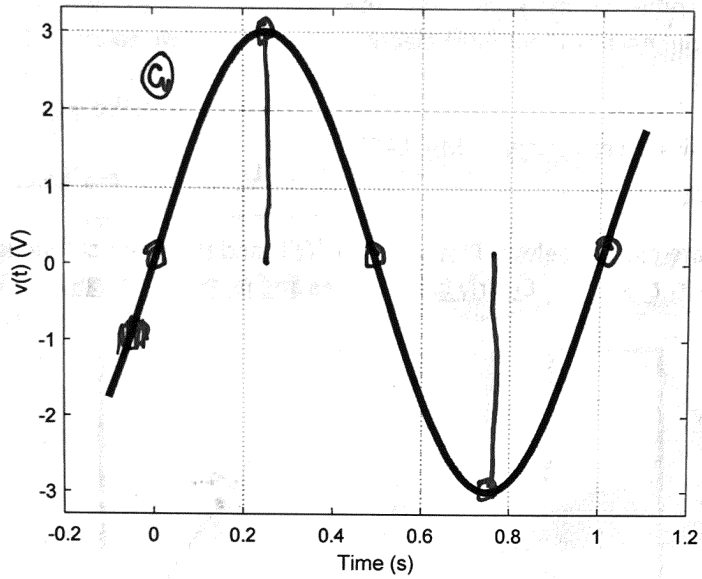
③ $f^*(t) = (x(t)y(t))^* = x^*(t)y^*(t) = \left(e^{+j100t}\right)\left(\frac{1}{3}t - \frac{\sqrt{3}}{2}j\right)$

conj. of original

No simplifications. IF we wanted Re or Im part, would ① distribute & ② apply Euler's formula: $e^{j(\omega t+\theta)} = \cos(\omega t+\theta) + j\sin(\omega t+\theta)$

4. For the analog sinusoidal voltage shown below, illustrate:

   a. Sampling the signal (going from continuous to discrete time) with a period of 0.25 s.
   b. Then quantizing the signal (going from continuous/analog voltage) with a resolution of 1 V.



(b) $v(nT_Q) \in \{-3, 0, 3\}$ V, all are $nQ = n \cdot 1V$ ↑ integer, so quantizing has no effect in this special case.

5. How many levels and how many bits are needed for each sample of the above signal?
6. How much total memory is needed to store the digital version of the signal?

(5)

n	nQ
-3	-3 V
-2	-2 V
-1	-1 V
0	0 V
1	1 V
2	2 V
3	3 V

↳ need 7 levels ∴ need $\lceil \log_2 7 \rceil = 3$ bits

In 3-bit register, store n as either
(a) 3-bit, 2's complement signed → [-4, 3] ← 1 unused level
(b) offset from -3 (unsigned 000...110) ← 111 unused

(6) 5 samples: $T/T_S + 1 = \frac{1}{0.25} + 1 = 4 + 1 = 5$ ↑ both edges

5 samples × 3 bits/sample = **15 bits**