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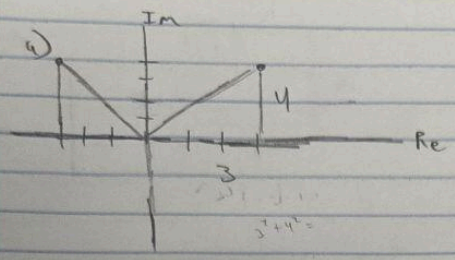
Homework #1

1) $z_1 = 3 + 4j$ $z_2 = -3 + 4j$

a)



$3^2 + 4^2 =$

b) $z_1 + z_2$

$= 8j$

c) $z_1 - z_2$

$= 6$

d) $z_1 \cdot z_2$

$= -9 - 16 \quad = -25$

e) z_1 / z_2

$\frac{(3+4j)}{(-3+4j)} \times \frac{(-3-4j)}{(-3-4j)}$ (conjugate of denom z_2)

$= \frac{7-24j}{25}$

f) $|z_1|$

$= \sqrt{3^2 + 4^2}$

$= 5$

g) $|z_2|$

$\sqrt{-3^2 + 4^2} \quad = 5$

h) $\phi_1 =$

$\phi_1 = \tan^{-1}\left(\frac{4}{3}\right)$

i)

$\phi_2 = \tan^{-1}\left(\frac{4}{-3}\right)$

j) polar form

$z_1 = 5e^{j\phi}$

$z_2 = 5e^{-j\phi}$

Homework #1

2) $\cos(2\pi ft) = \frac{e^{2\pi jft} + e^{-2\pi jft}}{2}$ Euler $e^{j\phi} = \cos\phi + j\sin\phi$

$\cos(2\pi ft) = \frac{e^{2\pi jft} + e^{2\pi jft}}{2}$ → $\cos\phi = \frac{e^{j\phi} + e^{-j\phi}}{2}$

$e^{2\pi jft} = \cos(2\pi ft) + j\sin(2\pi ft)$

$e^{-2\pi jft} = \cos(-2\pi ft) + j\sin(-2\pi ft)$

$\cos(-2\pi ft) = \cos(2\pi ft)$

$j\sin(-2\pi ft) = -j\sin(2\pi ft)$

$e^{2\pi jft} + e^{-2\pi jft} = (\cos(2\pi ft) + j\sin(2\pi ft)) + (\cos(2\pi ft) - j\sin(2\pi ft))$

$e^{2\pi jft} + e^{-2\pi jft} = 2\cos(2\pi ft) \Rightarrow \boxed{\cos(2\pi ft) = \frac{e^{2\pi jft} + e^{-2\pi jft}}{2}}$

$\sin(2\pi ft) = \frac{e^{2\pi jft} - e^{-2\pi jft}}{2j}$

$e^{2\pi jft} = \cos(2\pi ft) + j\sin(2\pi ft)$

$e^{-2\pi jft} = \cos(-2\pi ft) + j\sin(2\pi ft)$

$e^{2\pi jft} - e^{-2\pi jft} = (\cos(2\pi ft) + j\sin(2\pi ft)) - (\cos(2\pi ft) - j\sin(2\pi ft))$

$e^{2\pi jft} - e^{-2\pi jft} = 2j\sin(2\pi ft)$

$$\boxed{\sin(2\pi ft) = \frac{e^{2\pi jft} - e^{-2\pi jft}}{2j}}$$

Homework #1

3) $V_1(t) = 4\cos(2\pi f_1 t)$
$V_2(t) = 4\cos(2\pi f_2 t - \phi)$

$P = V_1(t) V_2(t)$

$P(t) = 4\cos(2\pi f_1 t) \cdot 4\cos(2\pi f_2 t - \phi) = 16\cos(2\pi f_1 t)\cos(2\pi f_2 t - \phi)$

$= 8(\cos(2\pi(f_1 - f_2)t + \phi) + \cos(2\pi(f_1 + f_2)t - \phi)$

trig sum

$8\cos(2\pi \underbrace{(f_1 - f_2)}_{f_-} t + \phi) + \cos(2\pi \underbrace{(f_1 + f_2)}_{f_+} t - \phi)$

b)

$f_1 = f_2 \quad \rightarrow \quad \phi = 0$

$P_{max} = 8[\cos(0) + \cos(4\pi f_1 t)]$
$= 8[1 + \cos 4\pi f_1 t]$
the max value is 1
$8(1 + 1) = 16$

16 is correct as the sinusoidal components are at their max ($\cos(4\pi f_1 t) = 1$). P(t) has amplitude of 8 times 2 cosines at max value which equals 16

Homework #1

4) $v_1(t) = \Im\{ e^{j(2\pi f_0 t - \phi)} \}$

$v_2(t) = \Im\{ e^{j(2\pi f_0 t)} \}$

a) $v_1(t) = \{e^{-j\phi}\}$ $\quad e^{-j\phi} = \cos\phi - j\sin\phi$

$v_2(t) = (1) = e^{0}$

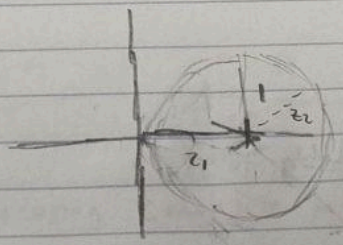
$v_1 + v_2 \quad 1 + e^{-j\phi} = \text{total} = z$

real $\qquad$ complex

$(1 + \cos(-\phi)) + j\sin(\phi)$

$\cos(-\theta) = \cos\theta$

a)



b)

$v_{tot} = 1 + e^{-j\phi}$

$z = 1 + \cos\phi - j\sin\phi$

$|z| = \sqrt{(1+\cos\phi)^2 + (\sin\phi)^2} = \sqrt{1 + 2\cos\phi + \cos^2\phi + \sin^2\phi}$

$|z| = \sqrt{2 + 2\cos(\phi)} = \boxed{2\left|\cos\left(\frac{\phi}{2}\right)\right|}$

Homework #1

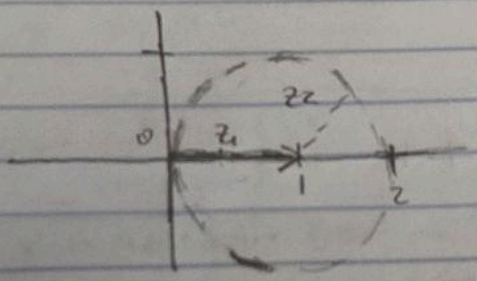
4c) $|z| = 2\left|\cos\left(\frac{45}{2}\right)\right| = \boxed{1.85}$

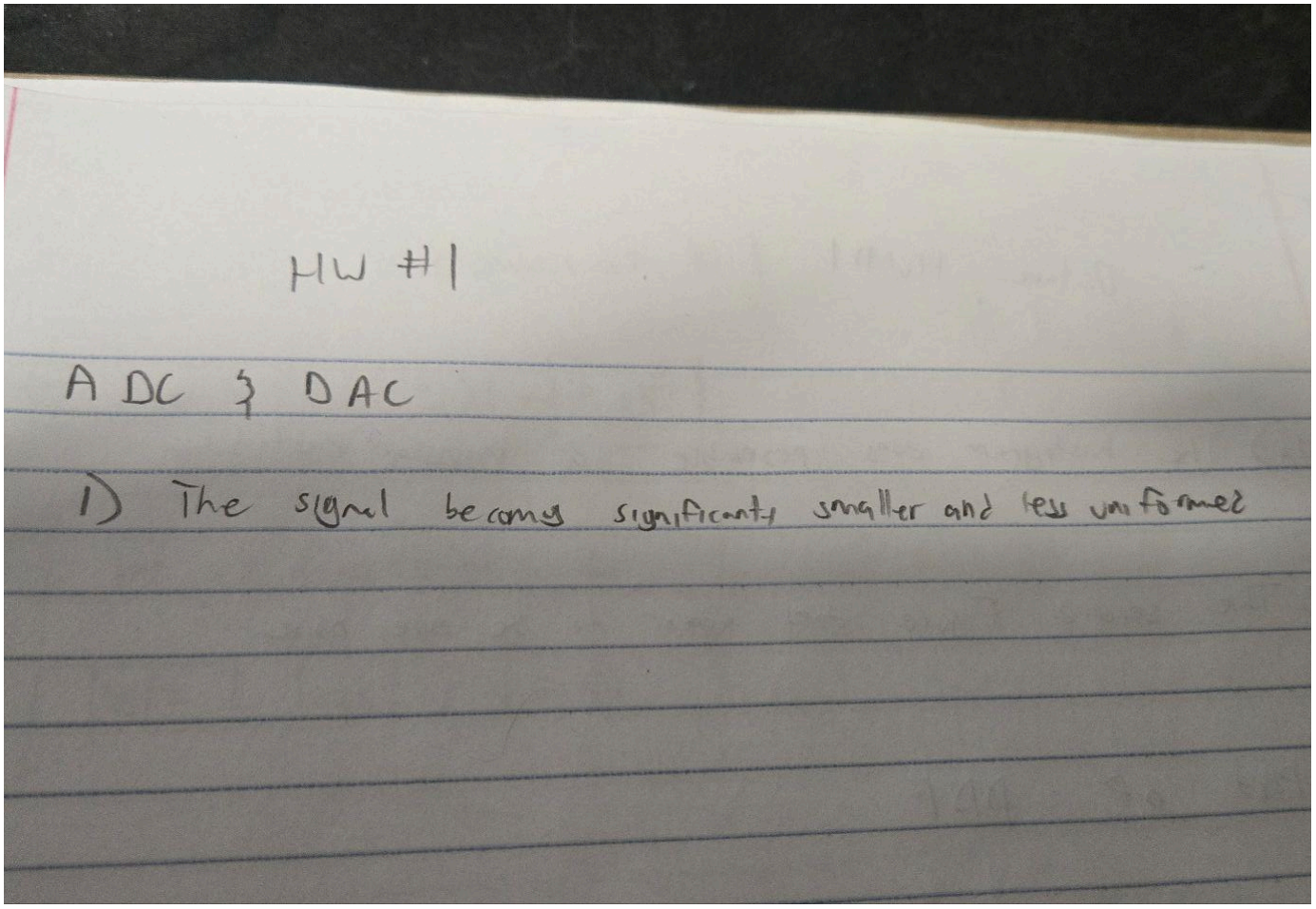
$|z| = 2\left|\cos\left(\frac{0}{2}\right)\right| = 2$

$|z| = 2\left|\cos\left(\frac{180}{2}\right)\right| = 0$

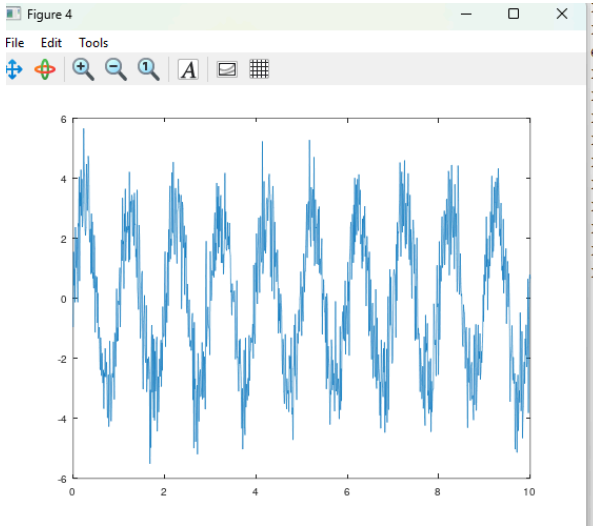
in phase (0°) the magnitude doubles to 2

out of phase (180°) the magnitude is cancelled to 0





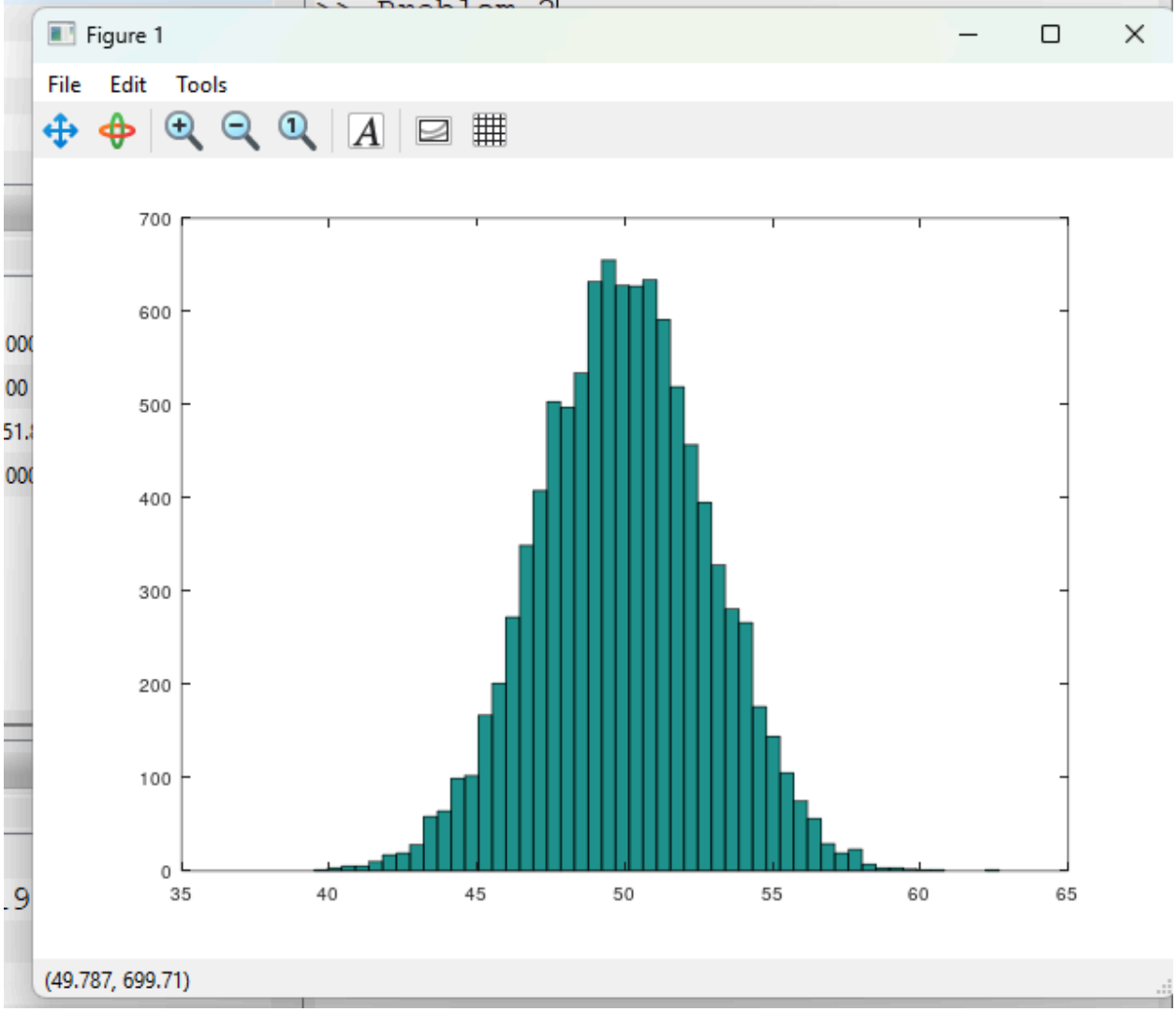
Problem 1c from Probability and Statistics, Noise



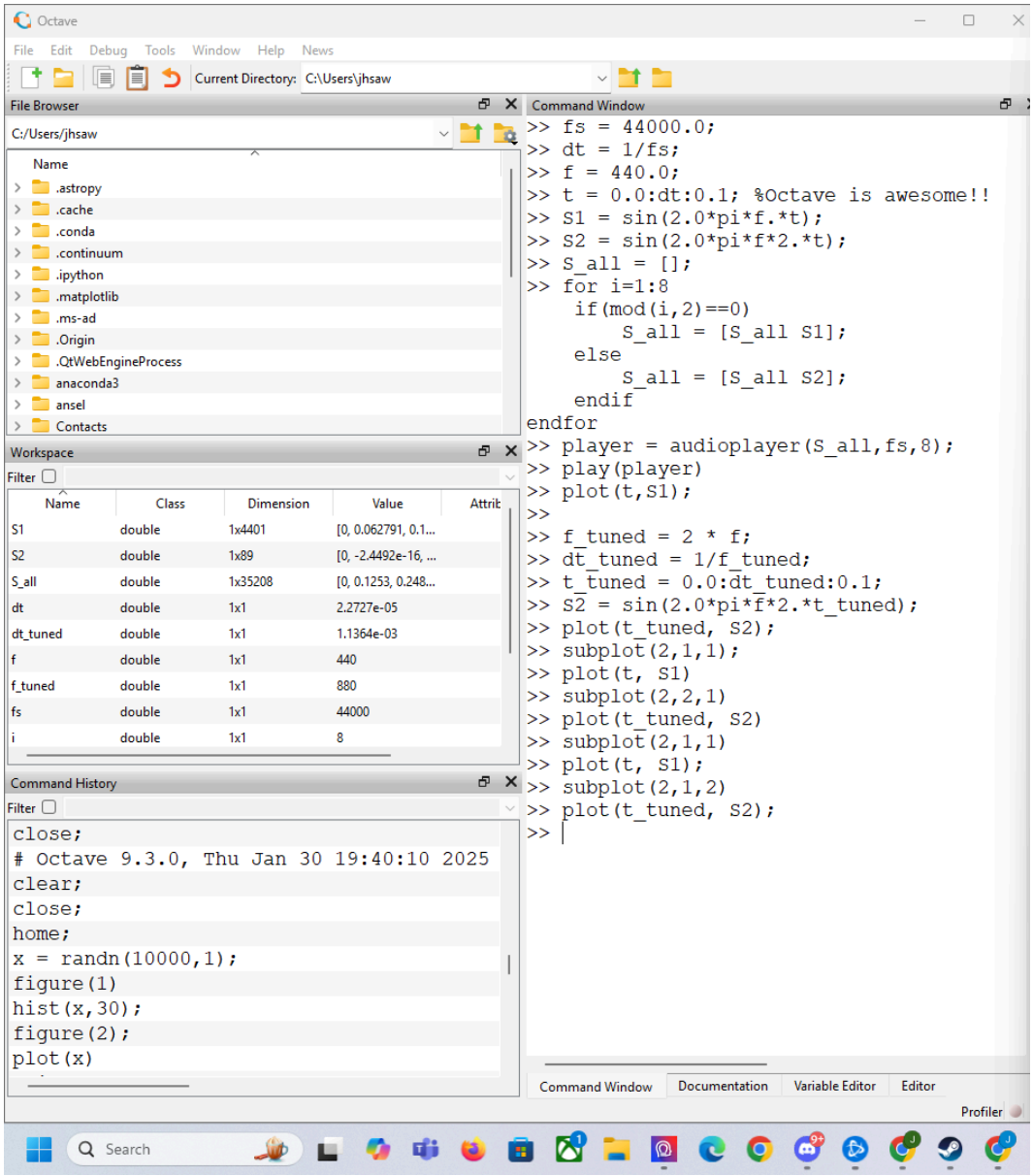

```
>>
>> Problem 1c
error: 'Problem' undefined near line 1, column 1
>> t = 0:0.01:10;
>> f = 1;
>>
>> A = 3;
>> y = A * sin(2*pi*f*t);
>> noise = randn(size(t));
>> y_noise = y + noise;
>> figure;
>> plot(t, y_noise);
>>
```

Problem 2 from Probability and Statistics, Noise

```
>> r = 100;
>> t = 10000;
>> sum_random = zeros(1, t);
>> for i = 1:t
sum_random(i) = sum(rand(1, r));
end
>> hist(sum_random, 50);
>> hist(sum_random, 50);
>>
```



Problem 1 from ADC and DAC



Plots for problem 1: ADC and DAC