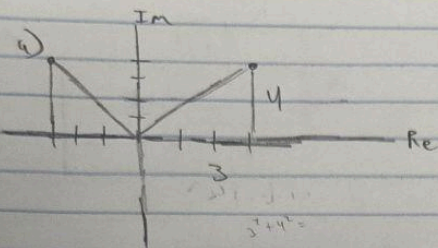


# Homework # 1

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



b)  $z_1 + z_2$

$= 8j$

c)  $z_1 - z_2$

$= 6$

d)  $z_1 \cdot z_2$

$= -9 - 16 = -25$

e)  $z_1 / z_2$

$\frac{(3+4j)}{(-3+4j)} \times \frac{(-3-4j)}{(-3-4j)}$

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

f)  $|z_1|$

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

$= 5$

g)  $|z_2|$

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

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

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

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

conjugate of  
denom  $z_2$

# Homework #1

$$2) \cos(2\pi ft) = \frac{e^{j2\pi ft} + e^{-j2\pi ft}}{2}$$

$$\text{Euler's } e^{j\theta} = \cos\theta + j\sin\theta$$

$$\star \cos(2\pi ft) = \frac{e^{j2\pi ft} + e^{-j2\pi ft}}{2}$$

$$\rightarrow \cos\theta = \frac{e^{j\theta} + e^{-j\theta}}{2}$$

$$e^{j2\pi ft} = \cos(2\pi ft) + j\sin(2\pi ft)$$

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

$$e^{-j2\pi ft} = \cos(-2\pi ft) + j\sin(-2\pi ft)$$

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

$$e^{j2\pi ft} + e^{-j2\pi ft} = (\cos(2\pi ft) + j\sin(2\pi ft)) + (\cos(2\pi ft) - j\sin(2\pi ft))$$

$$e^{j2\pi ft} + e^{-j2\pi ft} = 2\cos(2\pi ft) \Rightarrow \boxed{\cos(2\pi ft) = \frac{e^{j2\pi ft} + e^{-j2\pi ft}}{2}}$$

$$\sin(2\pi ft) = \frac{e^{j2\pi ft} - e^{-j2\pi ft}}{2j}$$

$$e^{j2\pi ft} = \cos(2\pi ft) + j\sin(2\pi ft)$$

$$e^{-j2\pi ft} = \cos(-2\pi ft) + j\sin(-2\pi ft)$$

$$e^{j2\pi ft} - e^{-j2\pi ft} = (\cos(2\pi ft) + j\sin(2\pi ft)) - (\cos(2\pi ft) - j\sin(2\pi ft))$$

$$e^{j2\pi ft} - e^{-j2\pi ft} = 2j\sin(2\pi ft)$$

$$\boxed{\sin(2\pi ft) = \frac{e^{j2\pi ft} - e^{-j2\pi ft}}{2j}}$$



# Homework #1

$$3) \quad \begin{aligned} V_1(t) &= 4 \cos(2\pi f_1 t) \\ V_2(t) &= 4 \cos(2\pi f_2 t - \phi) \end{aligned}$$

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

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

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

$$\xrightarrow{\text{trig id}} 8 \cos\left(2\pi \underbrace{(f_1 - f_2)}_{f_-} t + \phi\right) + \cos\left(2\pi \underbrace{(f_1 + f_2)}_{f_+} t - \phi\right)$$

b)

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

$$P_{\max} = 8 [\cos(0) + \cos(4\pi f_1 t)]$$

$$= 8 [1 + \cos(4\pi f_1 t)]$$

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

# Home work #1

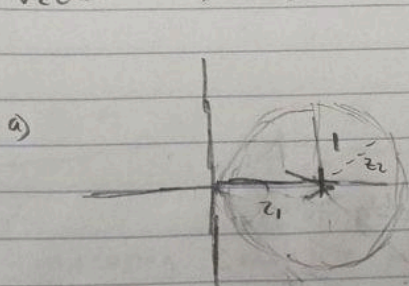
$$4) \quad v_1(t) = \mathcal{F} \{ e^{j(2\pi f_1 t - \phi)} \}$$

$$v_2(t) = \mathcal{F} \{ e^{j(2\pi f_2 t)} \}$$

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

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

$$e^{-j\phi} = \cos \phi - j \sin \phi$$



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

real      complex

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

$\cos(-\phi)$        $\sin(-\phi)$

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

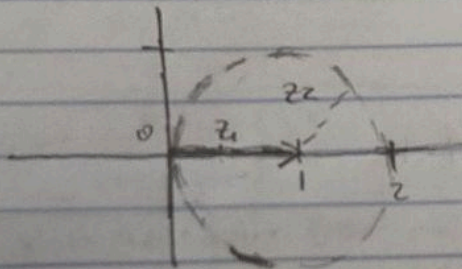
$$4c) |z| = 2 \left| \cos\left(\frac{45^\circ}{2}\right) \right| = \underline{1.85}$$

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

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

in phase ( $0^\circ$ ) the magnitude doubles to 2

out of phase ( $180^\circ$ ) the magnitude is cancelled to 0

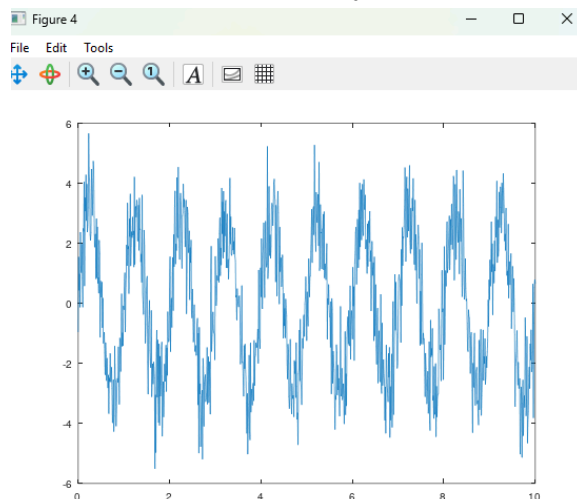


HW #1

A DC } DAC

1) The signal becoming significantly smaller and less uniform

### Problem 1c from Probability and Statistics, Noise



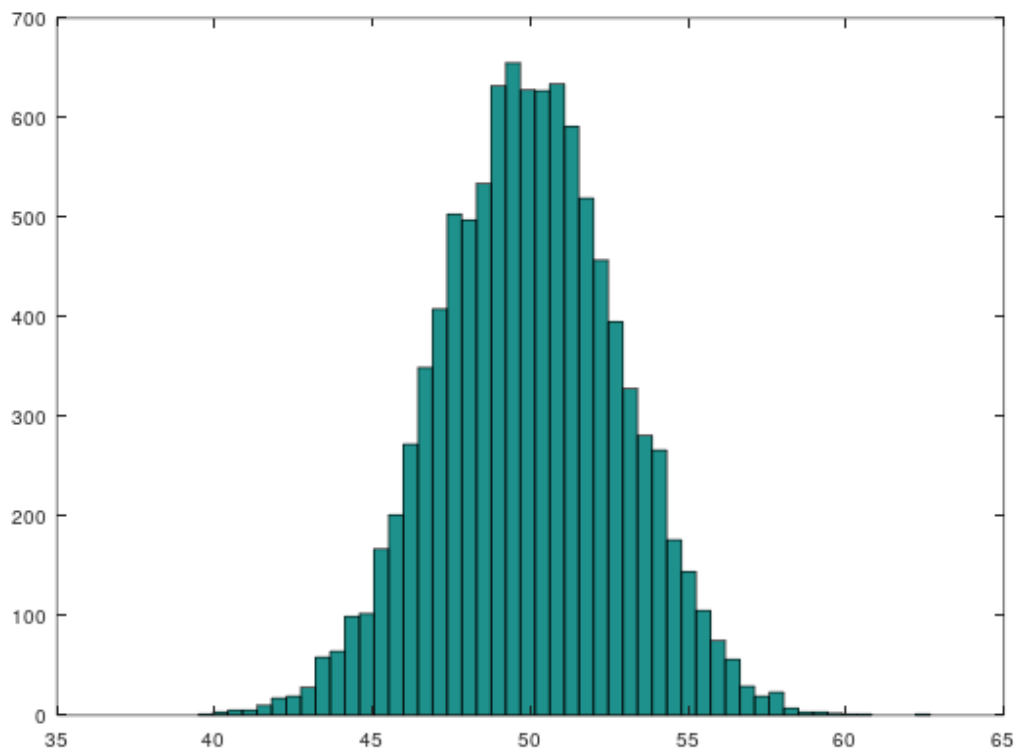
```
>> Problem 1c
error: 'Problem' undefined near line 1, column 1
>> t = 0:0.01:10;
>> f = 1;
>>
>> A = 3;
>> y = A * sin(2*pi*f*t);
>> noise = randn(size(t));
>> y_noise = y + noise;
>> figure;
>> plot(t, y_noise);
>>
```

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);  
>>
```

Figure 1

File Edit Tools



(49.787, 699.71)

## Problem 1 from ADC and DAC

The screenshot displays the Octave 9.3.0 interface. The main window is divided into several panes:

- File Browser:** Shows the directory structure of the current directory, C:\Users\jhsaw. The contents include folders like .astrophy, .cache, .conda, .continuum, .ipython, .matplotlib, .ms-ad, .Origin, .QtWebEngineProcess, anaconda3, ansel, and Contacts.
- Workspace:** A table listing the variables currently in the workspace. The table has columns for Name, Class, Dimension, Value, and Attributes.
- Command History:** A list of commands entered in the Command Window, including 'close;', '# Octave 9.3.0, Thu Jan 30 19:40:10 2025', 'clear;', 'close;', 'home;', 'x = randn(10000,1);', 'figure(1);', 'hist(x,30);', 'figure(2);', and 'plot(x);'.
- Command Window:** The area where the script is being executed. It shows the following code:

```
>> fs = 44000.0;
>> dt = 1/fs;
>> f = 440.0;
>> t = 0.0:dt:0.1; %Octave is awesome!!
>> S1 = sin(2.0*pi*f.*t);
>> S2 = sin(2.0*pi*f*2.*t);
>> S_all = [];
>> for i=1:8
    if(mod(i,2)==0)
        S_all = [S_all S1];
    else
        S_all = [S_all S2];
    endif
endfor
>> player = audioplayer(S_all,fs,8);
>> play(player)
>> plot(t,S1);
>>
>> f_tuned = 2 * f;
>> dt_tuned = 1/f_tuned;
>> t_tuned = 0.0:dt_tuned:0.1;
>> S2 = sin(2.0*pi*f*2.*t_tuned);
>> plot(t_tuned, S2);
>> subplot(2,1,1);
>> plot(t, S1)
>> subplot(2,2,1)
>> plot(t_tuned, S2)
>> subplot(2,1,1)
>> plot(t, S1);
>> subplot(2,1,2)
>> plot(t_tuned, S2);
>> |
```

The bottom of the screen shows the Windows taskbar with various application icons and the system clock.



## Plots for problem 1: ADC and DAC

