

ECE 2610 Lab Worksheet: MATLAB Intro & Complex Arithmetic

1/24/2011

MATLAB as a Complex Number Calculator

- Functions used: `real()`, `imag()`, `abs()`, `angle()`
- Compare the three angle producing functions: `angle()`, `atan2()`, and `atan()`

Practice Problems (very similar to Set #1)

For each of the problem below work out the answer using both MATLAB and your calculator

1. Write $127 - j75$ in polar form; find the angle in both radians and degrees.

```
>> z = 127 - j*75;
>> abs(z)
    ans = 147.4924
>> angle(z)
    ans = -0.5334 % In radians
>> angle(z)*180/pi
    ans = -30.5640 % In degrees
```

Hand/Calculator workspace:

From TI89
using the numerical
evaluate mode
(green diamond
button, then press
enter)

F1 Tools	F2 Algebra	F3 Calc	F4 Other	F5 Format	F6 Clean Up	
■ 127 - i · 75						147.492
■ angle(127 - i · 75)						-.533443
■ $\frac{\text{angle}(127 - i \cdot 75) \cdot 180}{\pi}$						-30.564
angle(127-i75)*180/pi						-30.564
MAIN		RAD AUTO		FUNC		3/30

- Since this number lies in quadrant IV, we are OK using the `atan()` to find the angle
- Watch out if in quadrant II or III
- Best to plot the complex number as a vector

2. Write $z = 22 \angle -110^\circ$ in rectangular form.

```
>> z = 22*exp(-j*110*pi/180)
    z = -7.5244 -20.6732i
>> real(z)
    ans = -7.5244
>> imag(z)
    ans = -20.6732
```

Hand/Calculator workspace:

A handheld calculator display showing the conversion of a complex number from polar to rectangular form. The top row of buttons is visible: F1 Tools, F2 Algebra, F3 Calc, F4 Other, F5 Pr3mID, F6 Clean Up. The screen shows the input $(22 \angle -110^\circ)$ followed by a division operation $\frac{22}{(-1)^{11/18}}$. An arrow points to this expression with the label "Symbolic/algebra form". Below this, the numerical result is shown: $(22 \angle -110^\circ)$ followed by $-7.52444 - 20.6732 \cdot i$. An arrow points to this result with the label "Numerical". The bottom of the screen shows the expression $(22 \angle -110^\circ)$ in a highlighted box, and the status bar at the bottom reads "MAIN RAD AUTO FUNC 2/30".

3. Evaluate $z = (15 - j37) - 60 \angle 45^\circ$ to a rectangular form solution.

MATLAB Steps:

```
>> (15 - j*37) - 60*exp(j*45*pi/180)
```

```
ans = -2.7426e+01 - 7.9426e+01i
```

Hand/Calculator workspace:

A handheld calculator display showing the evaluation of a complex expression. The top row of buttons is visible: F1 Tools, F2 Algebra, F3 Calc, F4 Other, F5 Pr3mID, F6 Clean Up. The screen shows the input $15 - i \cdot 37 - (60 \angle 45^\circ)$. Below this, the intermediate result is shown: $15 - 30 \cdot \sqrt{2} + (-30 \cdot \sqrt{2} - 37) \cdot i$. Below that, the numerical result is shown: $15 - i \cdot 37 - (60 \angle 45^\circ)$ followed by $-27.4264 - 79.4264 \cdot i$. The bottom of the screen shows the expression $(15 - i \cdot 37) - (60 \angle 45^\circ)$ in a highlighted box, and the status bar at the bottom reads "MAIN RAD AUTO FUNC 2/30".

4. Evaluate $z = (15 - j37)/60 \angle 45^\circ$ to a rectangular form solution.

MATLAB Steps:

```
>> (15 - j*37)/(60*exp(j*45*pi/180))
```

```
ans = -2.5927e-01 - 6.1283e-01i
```

Hand/Calculator workspace:

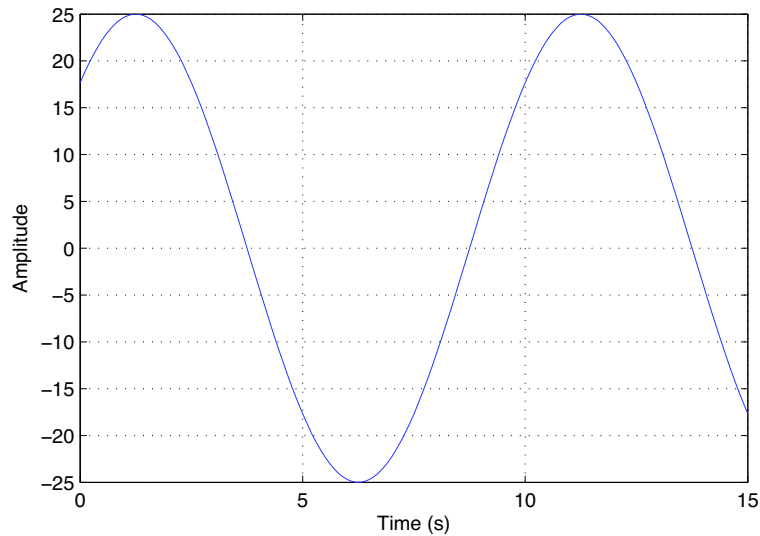
A handheld calculator display showing the division of a complex number. The top row of buttons is visible: F1 Tools, F2 Algebra, F3 Calc, F4 Other, F5 Pr3mID, F6 Clean Up. The screen shows the input $(60 \angle 45^\circ)$. Below this, the intermediate result is shown: $\frac{-11 \cdot \sqrt{2}}{60} - \frac{13 \cdot \sqrt{2}}{30} \cdot i$. Below that, the numerical result is shown: $\frac{15 - i \cdot 37}{(60 \angle 45^\circ)}$ followed by $-.259272 - .612826 \cdot i$. The bottom of the screen shows the expression $(15 - i \cdot 37) / (60 \angle 45^\circ)$ in a highlighted box, and the status bar at the bottom reads "MAIN RAD AUTO FUNC 2/30".

MATLAB for Plotting Data and Functions

- Functions used: `plot()`, `xlabel()`, `ylabel()`, `title()`, `grid`, and `axis`

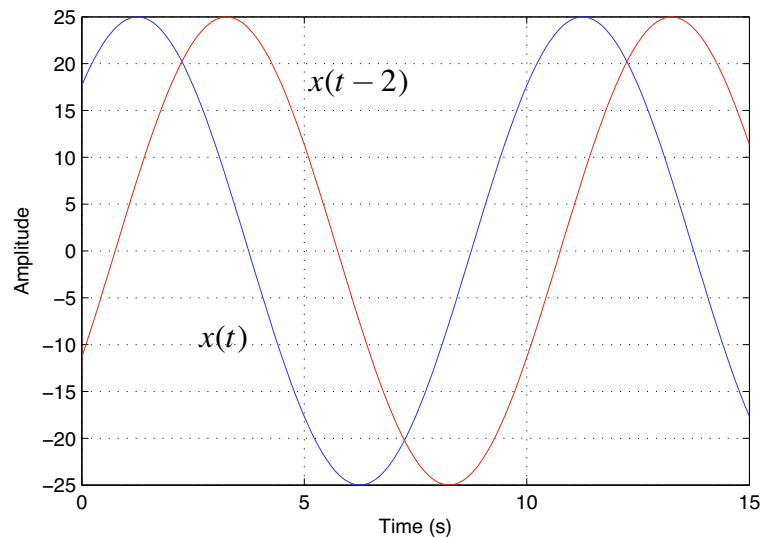
1. Plot $x(t) = 25 \sin(\pi t/5 + \pi/4)$ for $0 \leq t \leq 15$ s. Include a grid and axis labels.

```
>> t = 0:.1:15; % create a time axis vector with sample spacing 0.1s
>> plot(t,25*sin(pi*t/5+pi/4))
>> grid
>> xlabel('Time (s)')
>> ylabel('Amplitude')
>> print -depsc -tiff wks_fig1.eps
```



For the $x(t)$ above, plot $x(t-2)$ for $0 \leq t \leq 15$ s, overlaid on the plot of $x(t)$ of part (1).

```
>> hold on % will hold the previous plot so you can overlay a new plot
>> hold
Current plot held
>> plot(t,25*sin(pi*(t-2)/5+pi/4),'r')
>> print -depsc -tiff wks_fig2.eps
```



User Defined Functions in MATLAB

One of the most powerful capabilities of Matlab is being able to write your own user defined functions. Consider a custom trig function of the form

$$y(t) = 3 \cos(t) + 4 \sin(3t) \quad (1)$$

The input to this function is time, t , and the output is y . The function *prototype* we require is of the form:

```
function y = my_trig(t)
% y = my_trig(t) is a function that evaluates the simple trig
% based function y = 3*cos(t) + 4*sin(3*t).
%
% Author: My Name
% Date: January 2011
%
...
function body
...
make sure that you return output to variable y
```

Write the Function

```
function y = my_trig(t)
% y = my_trig(t)
% Mark Wickert, January 2011

y = 3*cos(t) + 4*sin(3*t);
```

Test the Function

To test the function input a time vector that runs from -2s to 10s using a time step of 0.05s. Output the results in a plot using `plot(t, y)`.

```
>> t = -2:.05:10;
>> y = my_trig(t);
>> plot(t,y)
>> grid
>> xlabel('Time (s)')
>> ylabel('Amplitude')
>> print -tiff -depsc
fig1.eps
```

