**Colorado Technical University**

 **Course:** MATH116 – Foundations for Calculus

# Unit 2 part 04 Readings: Real and Complex Zeros

**Review of Complex numbers**

remember:

≡ means "is defined to be"

 "imaginary" unit ***i*** ≡$\sqrt{-1}$

 complex numbers have a real and an imaginary part: *a* + *b****i***

 every real number is a complex number in which the imaginary part equals zero

 usually designated "z"

**Rules for complex numbers:**

 equality: *a* + *b****i*** = *c* + *d****i*** if *a=c* and *b=d*

 addition: (*a* + *b****i*** ) + (*c* + *d****i***) *=* (*a* + *c*) *+* (*b + d*)***i***

 subtraction: (*a* + *b****i*** ) – (*c* + *d****i***) *=* (*a* – *c*) *+* (*b* – *d*)***i***

 complex conjugate: (*a* + *b****i*** ) × (*a* – *b****i***) *= a*2*+ b* 2

For $\sqrt{-n}$ **ALWAYS TAKE OUT THE “*i* ” first!**

 $\sqrt{-4}$ = ***i*** $\sqrt{4}$ = 2 ***i***

 $\sqrt{-9}$ × $\sqrt{-36}$ = 3***i***× 6***i***= 18***i***2 = –18 (the right answer)

 **If you don’t take out the “***i***” first:

 $\sqrt{-9}$ × $\sqrt{-36}$ = $\sqrt{324}$ = 18 (the wrong answer)

**The Complex Plane**

imaginary unit *i =*$\sqrt{-1}$

*i =*$\sqrt{-1}$

 *i*2= –1

 *i*3= – *i*

*i*4= 1

*i*5= *i*

*.*

*.*

*.*

complex numbers can be plotted

as points on the complex plane

real axis (horizontal) and an

imaginary axis (vertical)

**Graphing Complex Numbers**

*i*

–2+*i*

1.5–2.5*i*

2+3*i*

We call the graph paper the "complex plane"

Given a complex number, to represent its components:

Move along the horizontal axis the amount of the real part

Move parallel to the vertical axis the amount of the imaginary part

Plot the point

**Complex Numbers in Electronics**

A common situation in [electrical networks](https://en.wikipedia.org/wiki/Electrical_network) is the existence of many sine-shaped waves all with

the same frequency but with different amplitudes and phases

They are represented by a real multiplier for frequency and time and a complex multiplier for

amplitude (**phasor**)

Combining these phasors is called **phasor arithmetic**

In AC circuits, resistors, capacitors, and inductors can be combined in a single complex

number called the **impedance** (in ohms, Ω):

Z = R + *j*·X

R is the resistance (a real number)

X is the reactance (imaginary)

These are generally written:

Z = (17 + *j*·1.5)Ω

The imaginary unit, *i*, is represented by the letter "*j*", to avoid confusion with current (*Ɪ* )

If two impedances are connected in series, the equivalent impedance is obtained by addition:

*Ze= Z1 + Z2*

The total impedance zT in a parallel circuit composed of circuits z1 and z2 is given by the formula: zT = $\frac{z\_{1}z\_{2}}{z\_{1}+z\_{2}}$

Kirchhoff's circuit laws (you will be running into them in your electrical engineering courses) work with phasors in complex form

