

FORTRAN 90

Lecturer : Rafel Hekmat Hameed

University of Babylon

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College of Engineering

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Mechanical Engineering Dep

Complex Numbers

A complex number is a number z of the form $z = x + iy$, where x and y are real numbers, and i is another number such that $i^2 = -1$.

When $z = x + iy$ as above, x is called the *real part* of z , and y is called the *imaginary part* of z . We often write yi instead of iy . For example, $3 + i2 = 3 + 2i$, and the real part of $3 + 2i$ is **3** and the imaginary part of $3 + 2i$ is **2**.

Addition and Multiplication of Complex Numbers

ADDITION: Two complex numbers are added simply by adding to-gather their real parts and imaginary parts:

For example, $(3 + 2i) + (4 - 6i) = (7 - 4i)$.

MULTIPLICATION: For example, we will have

$$\begin{aligned}(2 + 3i)(4 + 5i) &= 2(4 + 5i) + 3i(4 + 5i) \\ &= 8 + 10i + 12i + 15i^2 \\ &= 8 + 10i + 12i - 15 \\ &= -7 + 22i .\end{aligned}$$

Complex conjugate

If $z = x + iy$, the complex conjugate of z is the complex number defined by $\bar{z} = x - iy$.

Complex number in fortran 90

✚ **Complex** : Two real number stored as a pair and treated as the real and imaginary parts of a complex number.

Examples:

(1.234,-6.5E-3)

Where in this example, 1.234 is the real part of the complex constant and -0.0065 is the imaginary component.

EXAMPLE

Write a fortran 90 program to addition and multiplication two complex numbers x & y, also find the conjugate of x , $i*x*y$, and print the real and imaginary part of y.

Assume $x=1+i$, $y=1-i$

```
program complex_no
implicit none
complex:: x,y,i
x=(1,1)
y=(1,-1)
i=(0,-1)
write(*,5)x+y
5 format(2x,2f9.5)
write(*,6) conjg(x),i*x*y
6 format(2x,2f9.5,2x,2f9.5)
!print real part of y by real( )
write(*,7) real(y)
7 format (2x,f9.5)
```

```
!print imaginary part of y by imag( )
write(*,7) imag(y)
end
```

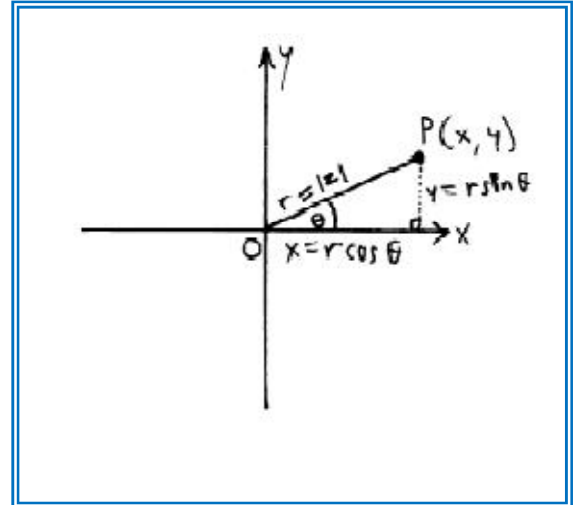
Modulus (Distance OP)

Denoted by r , $\text{mod } z$, $|z|$, $|x + iy|$
 by Pythagoras, $r^2 = x^2 + y^2$

$$r = \sqrt{x^2 + y^2}$$

$$r = |z| = |x + iy| = \sqrt{x^2 + y^2}$$

In fortran 90 the intrinsic function **cabs (z)**
 given the modulus of complex number z .



Argument (angle θ)

Denoted by θ , $\text{arg } z$, $\text{arg } (x + iy)$
 for $x \neq 0$, $\tan \theta = y/x$.

write a fortran 90 program to calculate the modulus and argument of $z=5-4i$ by function subprograms.

```
program complex_ma
implicit none
complex:: z
real:: ,modulus , argument
read(*,*)z
write(*,5)modulus(z)
write(*,*)"*****"
write(*,5)argument(z)
```

```

5 format(2x,f10.5)      ;      end
real function modulus (z)
implicit none
complex::z
modulus=cabs(z)
end

real function argument(z)
implicit none
real,parameter::pi=3.14159
real::theta
complex::z
theta= atan(imag(z)/real(z))
argument=(theta*180)/pi
end

```

Complex Array

$$A = \begin{vmatrix} 2 + 5i & 3 \\ 1 - 2i & 3 + 2i \end{vmatrix}, \quad B = \begin{vmatrix} 2 + 5i & 3 - 4i \\ 1 + 2i & 11 - 7i \end{vmatrix}$$

You can add, subtract, multiply,... these two matrices

Write a fortran 90 program to add these two matrices

```

program complex_ma
implicit none
complex,dimension(2,2)::a,c,b
integer::i,j
data a/(2,5),(1,-2),(3,0),(3,2)/
read(*,*)((b(i,j),j=1,2),i=1,2)
c=a+b
write(*,5)((c(i,j),j=1,2),i=1,2)
5 format(2(2x,2f9.5))
end

```