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ON TEACHING STUDENTS TO EXTRACT ROOTS FROM COMPLEX NUMBERS USING C++ SOFTWARE

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Teaching the students to connect the topics with their specialty subjects during the passage of the subjects of Higher Mathematics ensures that the students master the subject easily. It will be even more interesting if students are taught to find roots in a graphical form, in addition to giving them in the form of formulas, when examples are shown on the topic of extracting roots from complex numbers. The students of the software engineering direction suggested to get the results of the examples of this type using the C++ program. In this work, we compared the results of examples obtained by three different methods.

All complex numbers expressed in trigonometric form can be scaled according to Muavr's formula.

$$\underbrace{z = r(cos\varphi + isin\varphi), \quad \ldots\ldots , \quad z = r(cos\varphi + isin\varphi).}_{n}$$

Every step of the way

$$z * z * \dots * z = r * r * .. * r\left(\cos(\varphi + \varphi + \dots + \varphi) + i\sin(\varphi + \varphi + \dots + \varphi)\right)$$

n

from the fact that, according to the multiplication rule, the formula for raising complex numbers to a power arises.

$$z^n = r^n(cosn\varphi + isinn\varphi)$$

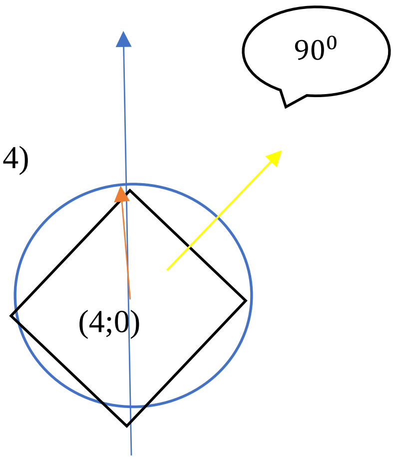
From the muavr formula, we create the root extraction formula:

$$\sqrt[n]{r \cdot (\cos\varphi + i \cdot \sin\varphi)} = \sqrt[n]{r} \cdot \left(\cos\frac{\varphi + 2\pi k}{n} + i \cdot \sin\frac{\varphi + 2\pi k}{n}\right).$$

k we have n different roots of the complex number .

n All the roots have their center at the beginning of the coordinates, and their radius $\sqrt[n]{r}$ lies at the vertices of a regular n-sided polygon inscribed in a circle equal to In this case, the roots of the complex number are formed using x and y of the three lying points. It is known that z1=5 and the radius is equal to 5. Accordingly, $360^0 : 3 = 120^0$ from the fact that we find the missing roots by taking into account the counter-clockwise turning angle of the complex numbers from the Ax axis.

In the following examples, we compare the results obtained using the formula and the graphical method with the result in the C++ program. $\sqrt[4]{256} = ?$ z_1=5 and the radius is equal to 5. Accordingly, we determine the angle: $360^0 : 3 = 120^0$



According to the complex number extraction formula

we find: $256 = 256 + 0 * i$.

The modulus of a complex number is 256.

Trigonometric view $z = 256(cos0 + isin0)$

ISSN: 2775-5118 VOL.3 NO.4 (2024) I.F. 9.1

Argument of a complex number $\varphi = 0$

$$\sqrt[4]{z} = \sqrt[4]{256}(cos\frac{0+2\pi k}{4} + isin\frac{0+2\pi k}{4})$$

$$k = 0\ da \quad \sqrt[4]{z} = 4(cos0^0 + isin0^0) = 4$$

$$k = 1\ da \quad \sqrt[4]{z} = 4\left(cos\frac{2\pi}{4} + isin\frac{2\pi}{4}\right) = 4i$$

$$k = 2\ da \quad \sqrt[4]{z} = 4\left(cos\frac{4\pi}{4} + isin\frac{4\pi}{4}\right) = -4$$

$$k = 3\ da \quad \sqrt[4]{z} = 4\left(cos\frac{6\pi}{4} + isin\frac{6\pi}{4}\right) = -4i$$

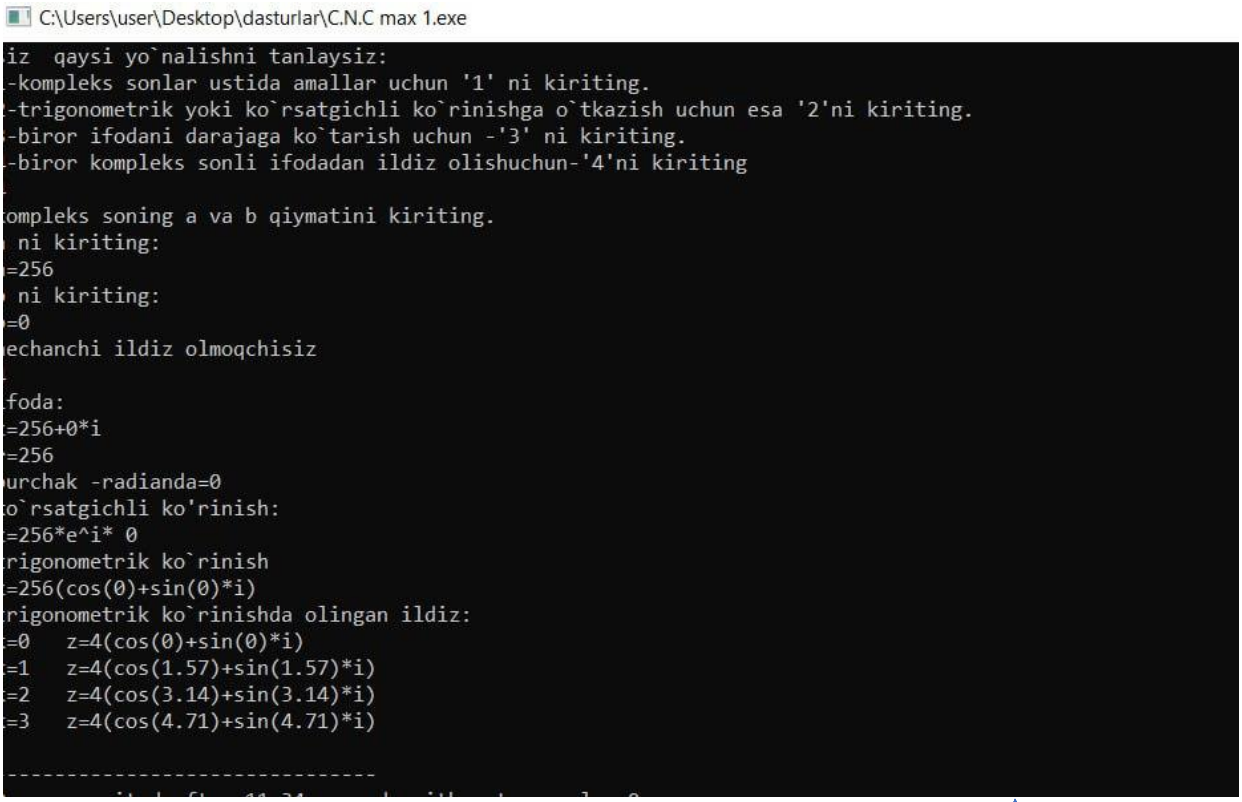
When we look graphically, it follows that z1=4 and the radius of the circle is equal to 4. Accordingly, we determine the angle $360^0 : 4 = 90^0$.

$$z_2 = 4(cos90^0 + isin90^0) = 4i$$

$$z_3 = 4(cos180^0 + isin180^0) = -4$$

$$z_4 = 4(cos270^0 + isin270^0) = -4i$$

Now we compare the result with the result of the program:



```
C:\Users\user\Desktop\dasturlar\C.N.C max 1.exe
iz  qaysi yo`nalishni tanlaysiz:
-kompleks sonlar ustida amallar uchun '1' ni kiriting.
-trigonometrik yoki ko`rsatgichli ko`rinishga o`tkazish uchun esa '2'ni kiriting.
-biror ifodani darajaga ko`tarish uchun -'3' ni kiriting.
-biror kompleks sonli ifodadan ildiz olishuchun-'4'ni kiriting

ompleks soning a va b qiymatini kiriting.
 ni kiriting:
=256
 ni kiriting:
=0
echanchi ildiz olmoqchisiz

foda:
=256+0*i
=256
urchak -radianda=0
o`rsatgichli ko'rinish:
=256*e^i* 0
rigonometrik ko`rinish
=256(cos(0)+sin(0)*i)
rigonometrik ko`rinishda olingan ildiz:
=0   z=4(cos(0)+sin(0)*i)
=1   z=4(cos(1.57)+sin(1.57)*i)
=2   z=4(cos(3.14)+sin(3.14)*i)
=3   z=4(cos(4.71)+sin(4.71)*i)

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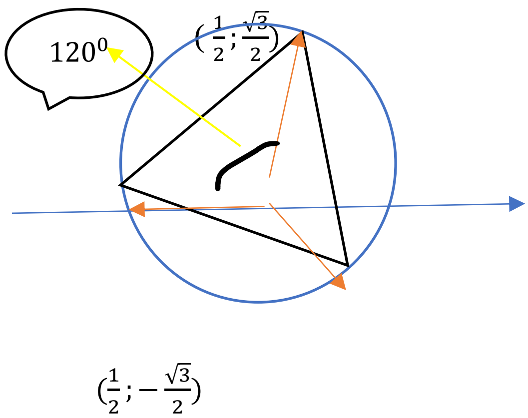
Let's look at the following example:

ISSN: 2775-5118 VOL.3 NO.4 (2024) I.F. 9.1

$\sqrt[3]{-1}=?$



View of a complex number: $-1=-1+0*i$,

modul $r=\sqrt{(-1)^2+0^2}=1$ (-1;0)

and argumenti will be $\varphi=\pi$.

$z=1(cos\pi+isin\pi)$

$\sqrt[3]{z}=\sqrt[3]{1}(cos\frac{\pi+2\pi k}{3}+isin\frac{\pi+2\pi k}{3})$

$k=0\ da\quad \sqrt[3]{z}=1\left(cos\frac{\pi}{3}+isin\frac{\pi}{3}\right)=\frac{1}{2}+i\frac{\sqrt{3}}{2}$

$k=1\ da\quad \sqrt[3]{z}=1\left(cos\frac{3\pi}{3}+isin\frac{3\pi}{3}\right)=-1$

$k=2\ da\ da\quad \sqrt[3]{z}=1\left(cos\frac{5\pi}{3}+isin\frac{5\pi}{3}\right)=\frac{1}{2}-i\frac{\sqrt{3}}{2}$

According to the graphic method, here we work by taking into account the angle of rotation of the complex numbers from the Ax axis.

It is known that z1=-1 and the radius of the circle is equal to 1 $360^0:3=120^0$.

z_1=-1 and the radius of the circle is equal to 1.

$z_2=1(cos60^0+isin60^0)=\frac{1}{2}+\frac{\sqrt{3}}{2}i$

$z_3=5(cos(-60^0)+isin(-60^0))=\frac{1}{2}-\frac{\sqrt{3}}{2}i.$

ISSN: 2775-5118 VOL.3 NO.4 (2024) I.F. 9.1

```
kompleks sonlar ustida amallar bajaruvchi palforma C.N.C. ga  hush kelibsiz
siz  qaysi yo`nalishni tanlaysiz:
1-kompleks sonlar ustida amallar uchun '1' ni kiriting.
2-trigonometrik yoki ko`rsatgichli ko`rinishga o`tkazish uchun esa '2'ni kiriting.
3-biror ifodani darajaga ko`tarish uchun -'3' ni kiriting.
4-biror kompleks sonli ifodadan ildiz olishuchun-'4'ni kiriting
4
kompleks soning a va b qiymatini kiriting.
a ni kiriting:
a=-1
b ni kiriting:
b=0
nechanchi ildiz olmoqchisiz
3
ifoda:
z=-1+0*i
r=1
burchak -radianda=-0
ko`rsatgichli ko'rinish:
z=1*e^i* -0
trigonometrik ko`rinish
z=1(cos(-0)+sin(-0)*i)
trigonometrik ko`rinishda olingan ildiz:
k=0   z=1(cos(1.04667)+sin(1.04667)*i)
k=1   z=1(cos(3.14)+sin(3.14)*i)
k=2   z=1(cos(5.23333)+sin(5.23333)*i)

--------------------------------
Process exited after 8.723 seconds with return value 0
Press any key to continue . . .
```

It can be seen that the results obtained by three different methods are the same.

Students read this topic several times to find the results of examples related to topics with the help of programs, in addition to developing mathematical formulas. They carefully study the examples of the topic. Only after that they will get results in the program. As a result, students will improve their knowledge of higher mathematics and programming.

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