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THE IMPORTANCE OF STUDYING $y = \sin\left(ax^2\right)$ THE FUNCTION IN STRENGTHENING STUDENTS' KNOWLEDGE OF TRIGONOMETRIC FUNCTIONS

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Аннотация: В данной статье рассмотрены задачи определения свойств и построения графиков функции вида $y = f(ax^2 + bx + c)$, когда f была тригонометрической функций. В качестве примера изучены свойства функций $y = \sin(ax^2 + bx + c)$, по этими свойствами сделаны научно-методические заключения. Для построения графики функций использованы современные

Ключевые слова: функция, сложная функция, квадратичная функция, тригонометрической функций, графики функции

Annotation: This article discusses the problem of determining the properties and graphing functions of the form $y = f(ax^2 + bx + c)$, when f there was a trigonometric function. As an example, the properties of functions a have been studied, and scientific and methodological conclusions have been made on these properties. To build the graphics functions used modern graphics programs GeoGebra and Maple.

Key words: Function, complex function, quadratic function, trigonometric functions, function graphs.

Funksiya tushunchasi matematikaning asosiy tushunchalaridan bo`lib, uning xossalari va grafigini chizish masalasi ko`p o`rganilgan. Ammo adabiyotlarda murakkab funksiya tushunchasi ta'riflari berilgani bilan argumenti kvadrat funksiyadan iborat murakkab funksiyalarni xossalarini aniqlash va grafigini chizish masalalari keltirilmagan. $y = f(ax^2 + bx + c)$ ko`rinishdagi funksiyalarni f trigonometrik funksiya bo`lgandagi xossalarini aniqlash va grafigini chizish masalasi muhimdir. Chunki ko`plab amaliy jarayonlarni ifodalovchi funksiyalar tarkibida trigonometrik funksiyalar ishtirok etadi. Xususan $f(x) = \sin x$ bo`lganda funksiya $y = \sin(ax^2 + bx + c)$ ko`rinishda bo`lib, ushbu funksiya $a, b, c$ parametrlarning turli xildagi qiymatlarida turlicha ko`rinish va xossalarga ega bo`ladi. Ushbu parametrlarning turli qiymatlarida yuzaga keladigan hollarni o`rganish naijasida bir qancha ilmiy- uslubiy xulosalar chiqarish mumkin. Biz quyida maqola hajmini inobatga olgan holda $a \quad 0$ $b = 0$ $c = 0$ holni o`rganish bilan chegaralanamiz. Ushbu turdagi funksiyalarning grafiklarini zamonaviy grafik chizuvchi dasturlar GeoGebra hamda Maple dasturlari yordamida chizish mumkin.

Bizga $y = \sin\left(ax^2\right)$ ($a \quad 0$) funksiya berilgan bo'lsin.

I. $f(x) = \sin\left(ax^2\right)$ funksiyaning aniqlanish sohasi va qiymatlar sohasi mos ravishda $D(x) = (- \quad ; \quad)$, $E(y) = (-1;1)$ ga teng;

II. $f(x) = \sin\left(ax^2\right)$ funksiya uzluksiz.

III. Funksiyaning juft, toqligi hamda davriyligini aniqlash:

a) $f(x)=\sin\left(ax^2\right)$ funksiya juft funksiya, ya’ni:

$f(-x)=\sin a(-x)^2=\sin ax^2=f(x)$;

b) davriy funksiya emas. Haqiqatdan,

$f(x)=\sin\left(a(x+T)^2\right)=\sin(ax^2+2axT+aT^2)$

$f(x)=f(x+T)$ tenglik bajarilishi uchun $aT^2+2axT=2\pi k, k \quad Z$ bo`lishi kerak. Endi $aT^2+2axT=2\pi k, k \quad Z$ kvadrat tenglamani yechsak

$aT^2+2axT-2\pi k=0, k \quad Z \qquad T_{1,2}=\dfrac{-2ax\pm\sqrt{4a^2x^2+8a\pi k}}{2a}$

yechimlarga ega bo`lamiz. Bu yechimlar esa funksiya davri bo`la olmaydi, chunki noma’lum x ga bog`liq bo`lib qoldi.

IV. Funksiya grafigining koordinata o`qlari bilan kesishish nuqtalarini topish:

Oy o`qi bilan: $x=0$ da $f(x)=0$;

Ox o`qi bilan $f(x)=0$ bo`lganda:

a) $a>0$ bo`lganda $y(x)=\sin ax^2=\sin|a|x^2$

b) $a<0$ bo`lganda $y(x)=\sin ax^2=-\sin|a|x^2$ ekanligidan

$y(x)=\sin|a|x^2=0$, $|a|x^2=\pi k$,

$x_{1,2}=\pm\sqrt{\dfrac{\pi k}{|a|}}, \quad k \quad Z^+ \quad \{0\}$.

Shunday qilib, funksiya grafigi koordinata o`qlari bilan $M \; \sqrt{\dfrac{\pi k}{|a|}},0$ va $N \; -\sqrt{\dfrac{\pi k}{|a|}},0 \quad k \quad Z^+ \quad \{0\}$ nuqtalarda kesishadi.

V. Funksiyaning ishorasi saqlanadigan oraliqlarni aniqlaymiz, aniqlanish sohasini nuqtalar yordamida funksiya nolga teng bo`ladigan intervallarga ajratamiz. Bu intervallarning har birida funksiyaning ishorasini tekshiramiz:

Malumki, $y=\sin x$ funksiyaning qiymatlari $x \quad (2\pi k, \pi+2\pi k)$ oraliqda musbat, grafigi esa Ox o`qi ustida joylashadi; $x \quad (\pi+2\pi k, 2\pi+2\pi k)$ oraliqda esa funksiya qiymatlari manfiy grafigi $Ox$ o`qi ostida joylashadi. Ushbu xossalarni qo`llab, quyidagilarga ega bo`lamiz:

a) $a>0$ bo`lganda:

1. $2\pi k<ax^2<\pi+2\pi k, \quad \dfrac{2\pi k}{a}<x^2<\dfrac{\pi+2\pi k}{a}, k \quad Z$

Bu tengsizlikda intervallar usulidan foydalanib, yechimlarni topamiz:

$$x \quad -\sqrt{\frac{\pi+2\pi k}{a}},-\sqrt{\frac{2\pi k}{a}} \qquad \sqrt{\frac{2\pi k}{a}},\sqrt{\frac{\pi+2\pi k}{a}} \quad k \quad Z^+\{0\}$$

oraliqda funksiya qiymati musbat, grafigi Ox o`qi ustida joylashadi;

2. $\pi+2\pi k<ax^2<2\pi+2\pi k, \quad \dfrac{\pi+2\pi k}{a}<x^2<\dfrac{2\pi+2\pi k}{a}, k \quad Z$

Bu tengsizlikda ham intervallar usulidan foydalanib, yechimlarni topamiz:

$$x \quad -\sqrt{\frac{2\pi+2\pi k}{a}},-\sqrt{\frac{\pi+2\pi k}{a}} \qquad \sqrt{\frac{\pi+2\pi k}{a}},\sqrt{\frac{2\pi+2\pi k}{a}} \quad k \quad Z^+\{0\}$$

oraliqda funksiya qiymati manfiy, grafigi Ox o`qi ostida joylashadi.

b) $a<0$ bo`lganda esa ushbu $\sin(-x)=-\sin(x)$ xossaga ko`ra ushbu holdagi funksiya grafigi yuqorida ko`rilgan funksiya grafigiga $Ox$ o`qiga nisbatan simmetrik bo`lib, sohaga bog`liq xossalar teskarisiga almashadi.

VI. Funksiyaning monotonlik oraliqlarini topish va ekstremumga tekshirish

$f(x)=\sin\left(ax^2\right)$ funksiya hosilasini olib nolga tenglab ishlasak:

a) $a>0$ bo`lganda

$$f'=\left(\sin ax^2\right)=a\ \ 2x\ \ \cos ax^2=0$$

$$x_1=0,\quad ax^2=\frac{\pi}{2}+\pi k\qquad x_{2,3}=\pm\sqrt{\frac{\pi}{2a}+\frac{\pi k}{a}}=\pm\sqrt{\frac{\pi+2\pi k}{2a}}=\pm\sqrt{\frac{(2k+1)\pi}{2a}}\quad k\ \ Z^+\ \ \{0\}$$

bo'lib, bunda x_1, x_2, x_3 nuqtalar $f(x)$ funksiyaning statsionar nuqtalari.

$x_1=0$ nuqtada funksiya lokal minimumga erishadi. Agar,

$k-$ *juft son bo'lsa* $x_{2,3}$ *nuqta* $f(x)$ *funksiyaning maksimum nuqtasi bo'ladi*;

$k-$ *toq son bo'lsa* $x_{2,3}$ *nuqta* $f(x)$ *funksiyaning* min*imum nuqtasi bo'ladi.*

$$x\quad -\sqrt{\frac{(4k+3)\pi}{2a}};-\sqrt{\frac{(4k+1)\pi}{2a}}\qquad 0;\sqrt{\frac{\pi}{2a}}\qquad \sqrt{\frac{(4n-1)\pi}{2a}};\sqrt{\frac{(4n+1)\pi}{2a}}\quad n\ \ Z^+,k\ \ Z^+\ \ \{0\}$$

Oraliqda $f\ (x)>0$ bundan funksiya grafigi o`suvchi;

$$x\quad -\sqrt{\frac{(4n+1)\pi}{2a}};-\sqrt{\frac{(4n-1)\pi}{2a}}\qquad -\sqrt{\frac{\pi}{2a}};0\qquad \sqrt{\frac{(4k+1)\pi}{2a}};\sqrt{\frac{(4k+3)\pi}{2a}}\quad n\ \ Z^+,k\ \ Z^+\ \ \{0\}$$

Oraliqda $f\ (x)<0$ bundan funksiya grafigi kamayuvchi;

b) $a<0$ bo`lganda

$$f'=\left(\sin ax^2\right)=a\ \ 2x\ \ \cos ax^2=0$$

$$x_1=0,\quad ax^2=\frac{\pi}{2}+\pi k\qquad x_{2,3}=\pm\sqrt{\frac{\pi}{2|a|}+\frac{\pi k}{|a|}}=\pm\sqrt{\frac{\pi+2\pi k}{2|a|}}\quad k\ \ Z^+\ \ \{0\}$$

bo'lib, bunda x_1, x_2, x_3 nuqtalar $f(x)$ funksiyaning kritik nuqtalari. Agar,

$k-$ *juft son bo'lsa* $x_{2,3}$ *nuqta* $f(x)$ *funksiyaning* min*imum nuqtasi bo'ladi*;

$k-$ *toq son bo'lsa* $x_{2,3}$ *nuqta* $f(x)$ *funksiyaning maksimum nuqtasi bo'ladi.*

$$x\quad -\sqrt{\frac{(4k+3)\pi}{2a}};-\sqrt{\frac{(4k+1)\pi}{2a}}\qquad 0;\sqrt{\frac{\pi}{2a}}\qquad \sqrt{\frac{(4n-1)\pi}{2a}};\sqrt{\frac{(4n+1)\pi}{2a}}\quad n\ \ Z^+,k\ \ Z^+\ \ \{0\}$$

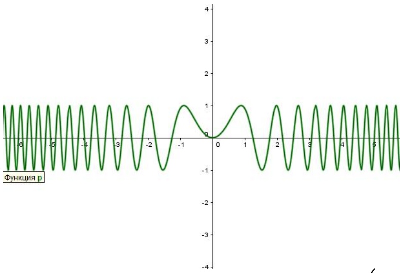
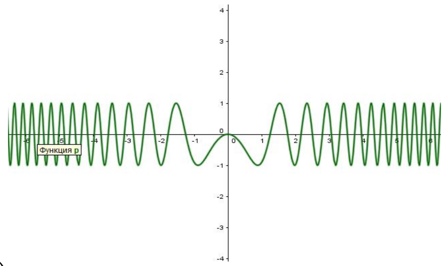
oraliqda $f\ (x)<0$ bundan funksiya grafigi kamayuvchi;

$$x\quad -\sqrt{\frac{(4n+1)\pi}{2a}};-\sqrt{\frac{(4n-1)\pi}{2a}}\qquad -\sqrt{\frac{\pi}{2a}};0\qquad \sqrt{\frac{(4k+1)\pi}{2a}};\sqrt{\frac{(4k+3)\pi}{2a}}\quad n\ \ Z^+,k\ \ Z^+\ \ \{0\}$$

oraliqda $f\ (x)>0$ bundan funksiya grafigi o`suvchi;

VII. $f(x)=\sin\left(ax^2\right)$ funksiya grafigi assimptotalarga ega emas. Funksiya grafigining simmetriya o`qi esa $x=0$ chiziq ya'ni $Oy$ o`qi bo'ladi chunki u juft funksiya.

VIII. Funksiya grafigini chizish.

1- chizma ($f(x)=\sin\left(2x^2\right)$) 2 - chizma ($f(x)=\sin\left(-2x^2\right)$)

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