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Quramboyev Islomjon Nuraddin o'g'li

“Axborotlarga ishlov berish va boshqarish tizimlari” kafedrası talabasi
Toshkent Davlat Texnika Universiteti,
O'zbekiston Respublikasi, Toshkent shahri

Quromboyev Hamdambek Nuraddinovich

“Matematika o'qitish metodikasi va geometriya” kafedrası o'qituvchisi
Chirchiq davlat pedagogika universiteti,
O'zbekiston Respublikasi, Toshkent viloyati

TALABALAR FAN OLIMPIADASIDA UCHRAYDIGAN NOSTANDART MASALALARNI YECHISH USULLARI

Ushbu maqolada Oliy matematika fanidan nomatematik bakalavr yo'nalishi talabalari uchun fan olimpiada masalalarida uchraydigan ba'zi bir nostandart masalalarni yechishning qulay usullari keltirilgan.

В данной статье представлены удобные способы решения некоторых нестандартных задач, встречающихся в задачах олимпиады по науке для студентов нематематического бакалавриата по высшей математике.

In this article, convenient ways to solve some non-standard problems found in Science Olympiad problems for students of non-mathematical bachelor's degree in Higher Mathematics are presented.

Yurtimiz azaldan matematika faniga katta hissa qo'shgan olimlari bilan butun dunyoga tanilgan. Bularga misol sifatida ulug' boblarimiz Muhammad ibn Muso al-Xorazmiy, Ahmad Farg'oniy, Abu Rayhon Beruniy, Ibn-Sino, Forobiy, Ulug'bek kabi bobokalonlarimizni ko'rsatish mumkin. Ularning izdoshlari sifatida O'zbekistonda zamonaviy matematika muammolari bilan shug'ullanuvchi maktab asoschilari bo'lmish akademiklar T.N. Qori-Niyoziy, T.A. Sarimsoqov, S.X. Sirojiddinov, T.J. Jo'rayev, T.A. Azlarov, N.Yu. Satimov kabi juda ko'p ustozlarimizni ko'rsatish mumkin. O'quvchilar matematika fani bo'yicha olimpiadalarda muvaffaqiyatli qatnashishlari uchun juda ko'p qo'shimcha adabiyotlarni o'rganishlari, nostandart masala-misollarni yechishni mashq qilishlari talab etiladi. Bu ularning tug'ma qobiliyatlarini kuchayishga, masalalarni yechishda "olimpiadacha mushohida" qilish tajribasini oshishiga olib keladi. Biz quyidagicha nostandart masalalarni keltiramiz va yechimini ko'rsatamiz.

1. $f(x) = |x-1| + |2x-1| + |3x-1| + \dots + |119x-1|$ funksiyaning eng kichik qiymatini toping.

Yechim: Berilgan funksiyaning grafigi $(-\infty, 1/119)$ oraliqda

$$f(x) = (1-x) + (1-2x) + \dots + (1-118x) + (1-119x) =$$

$$= 119 - (1+2+\dots+118+119)x = 119 - (119 \cdot 120/2)x = 119 - 60 \cdot 119x$$

to'g'ri chiziqdan, $(1, \infty)$ oraliqda esa

$$f(x) = (x-1) + (2x-1) + \dots + (118x-1) + (119x-1) = 60 \cdot 119x - 119$$

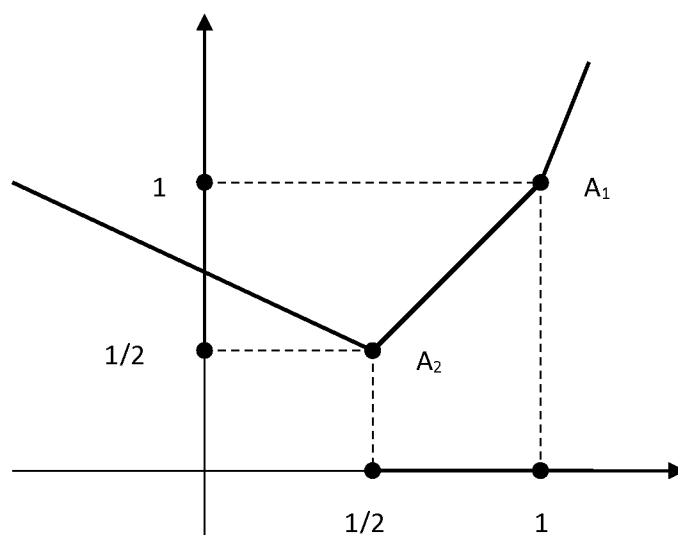
to'g'ri chiziqdan iborat.

$[1/119, 1]$ kesmada esa $f(x)$ grafigi $A_m A_{m+1}$, $k=1, 2, 3, \dots, 118$, kesmalardan iborat siniq chiziqdan iborat bo'lib, A_m nuqtalarning koordinatalari $x_m=1/m$, $y_m=f(x_m)$ kabi aniqlanadi.

Masalan,

$$f(x) = |x-1| + |2x-1| = \begin{cases} x-1+2x-1=3x-2, & x \in (1, \infty) \\ 1-x+2x-1=x, & 1/2 \leq x \leq 1 \\ 1-x+1-2x=-3x+2, & x \in (-\infty, 1/2) \end{cases}$$

funksiyaning grafigi quyidagi siniq chiziqdan iborat:



Bu yerdan ko'rinadiki $f(x)$ funksiya o'zining eng kichik $\min f$ qiymatiga $x=1/m$, $m=1,2, \dots, 119$, nuqtalardan birida erishadi. Keyingi mulohazalarni ixcham ko'rinishda ifodalash uchun

$$a_1 + a_2 + a_3 + \dots + a_n = \sum_{k=1}^n a_k$$

yig'indi belgisidan foydalanamiz. Bu holda berilgan $f(x)$ funksiya va uning $x=1/m$, $m=1,2, \dots, 119$, nuqtalardagi qiymatlari quyidagicha ifodalalnadi [1]:

$$f(x) = |x-1| + |2x-1| + |3x-1| + \dots + |119x-1| = \sum_{k=1}^{119} |kx-1|, \quad f\left(\frac{1}{m}\right) = \sum_{k=1}^{119} \left| \frac{k}{m} - 1 \right|.$$

Absolyut qiymat ta'rifiga asosan

$$\left| \frac{k}{m} - 1 \right| = \begin{cases} 1 - \frac{k}{m}, & k=1,2,\dots,m \\ \frac{k}{m} - 1, & k=m+1,\dots,119 \end{cases}$$

va shu sababli

$$\begin{aligned} f\left(\frac{1}{m}\right) &= \sum_{k=1}^{119} \left| \frac{k}{m} - 1 \right| = \sum_{k=1}^m \left| \frac{k}{m} - 1 \right| + \sum_{k=m+1}^{119} \left| \frac{k}{m} - 1 \right| = \sum_{k=1}^m \left(1 - \frac{k}{m}\right) + \sum_{k=m+1}^{119} \left(\frac{k}{m} - 1\right) = \\ &= \sum_{k=1}^m 1 - \frac{1}{m} \sum_{k=1}^m k + \frac{1}{m} \sum_{k=m+1}^{119} k - \sum_{k=m+1}^{119} 1 = \\ &= m - \frac{1}{m} \frac{m(m+1)}{2} + \frac{1}{m} \frac{(m+1)+119}{2} \cdot (119-m) - (119-m) = \\ &= \frac{m-1}{2} + (119-m) \cdot \frac{120-m}{2m} = \frac{m(m-1) + (119-m)(120-m)}{2m} = m + \frac{7140}{m} - 120. \end{aligned}$$

Bu yerda $\sum_{k=r}^n 1 = n - r + 1$ tenglikdan va birinchi hadi r , ayirmasi 1 bo'lgan arifmetik

progressiya hadlari yig'indisi formulasiga asosan [2], $\sum_{k=r}^n k = \frac{r+n}{2} \cdot (n-r+1)$ ekanligidan

foydalanildi. Bu holda

$$\min f = \min_{1 \leq m \leq 119} f\left(\frac{1}{m}\right) = \min_{1 \leq m \leq 119} \left(m + \frac{7140}{m} - 120\right) = \min_{1 \leq m \leq 119} \left(m + \frac{7140}{m}\right) - 120.$$

Bu minimumni topish uchun ushbu $g(x)$ funksiyani qaraymiz va uni hosila yordamida ekstremumga tekshiramiz:

$$g(x) = x + \frac{7140}{x} \quad (x > 0) \Rightarrow g'(x) = 1 - \frac{7140}{x^2} = 0 \Rightarrow x_{kr} = \sqrt{7140} \approx 84,5.$$

Bunda $g'(x) < 0$ ($x < x_{kr}$) va $g'(x) > 0$ ($x > x_{kr}$) bo'lgani uchun bu funksiya x_{kr} nuqtada minimumga ega. Bu yerdan ko'rinadiki $\min f$ qiymati $m = [x_{kr}] = 84$ yoki $m = [x_{kr}] + 1 = 85$ bo'lganda hosil bo'ladi:

$$f\left(\frac{1}{84}\right) = 84 + \frac{7140}{84} - 120 = 84 + 85 - 120 = 49, \quad f\left(\frac{1}{85}\right) = 85 + \frac{7140}{85} - 120 = 49.$$

Demak, berilgan funksiya $f(x)$ o'zining eng kichik qiymatiga $x = 1/84$ va $x = 1/85$ nuqtalarda erishadi va $\min f = 49$. **Javob:** $\min f = 49$.

Izoh: Izlanayotgan $\min f$ erishiladigan $x = 1/m$ nuqtadagi m natural sonni hosila tushunchasi yordamisiz ham topish mumkin. Ma'lumki, har qanday musbat a soni uchun $a + 1/a \geq 2$ tengsizlik o'rinli va unda eng kichik qiymat faqat $a = 1$ bo'lganda erishiladi. Bizning masalada

$$m + \frac{7140}{m} = \sqrt{7140} \left(\frac{m}{\sqrt{7140}} + \frac{\sqrt{7140}}{m} \right)$$

bo'lgani uchun bu ifodaning eng kichik qiymati $m = \sqrt{7140} \approx 84,5$ bo'lganda erishiladi. Bu yerdan va m natural son ekanligidan $m = 84$ yoki $m = 85$ ekanligi kelib chiqadi.

$$2. P(x^2) + x[3P(x) + P(-x)] = [P(x)]^2 + 2x^2, \quad \forall x \in R, \text{ tenglikni}$$

qanoatlantiruvchi barcha haqiqiy koeffitsientli $P(x)$ ko'phadlarni toping.

Yechim: Masala shartidagi tenglik ixtiyoriy x uchun o'rinli bo'lgani uchun x o'rniga $-x$ qo'yishimiz mumkin:

$$\begin{cases} P(x^2) + x[3P(x) + P(-x)] = [P(x)]^2 + 2x^2 \\ P(x^2) - x[3P(-x) + P(x)] = [P(-x)]^2 + 2x^2 \end{cases}$$

Bu sistemadagi tengliklarni hadma-had ayiramiz:

$$4x[P(x) + P(-x)] = [P(x)]^2 - [P(-x)]^2 \Rightarrow \begin{cases} P(x) + P(-x) = 0 \\ P(x) - P(-x) = 4x \end{cases}$$

Birinchi $P(x) + P(-x) = 0$ holda $P(x)$ ko'phad toq funksiya va shu sababli

$$P(x) = p_0x + p_1x^3 + p_2x^5 + \dots + p_nx^{2n+1} = \sum_{k=0}^n p_kx^{2k+1}, \quad p_n \neq 0. \quad (1)$$

ko'rinishda bo'ladi. Bu holda berilgan tenglamadan quyidagi natijalarni olamiz:

$$P(x^2) - x^2 = P^2(x) - 2xP(x) + x^2 \Rightarrow P(x^2) - x^2 = [P(x) - x]^2 \Rightarrow$$

$$\Rightarrow (p_0 - 1)x^2 + \sum_{k=1}^n p_kx^{2(2k+1)} = [(p_0 - 1)x + \sum_{k=1}^n p_kx^{2k+1}]^2 =$$

$$= (p_0 - 1)^2x^2 + 2(p_0 - 1)x \sum_{k=1}^n p_kx^{2k+1} + \left[\sum_{k=1}^n p_kx^{2k+1} \right]^2 \Rightarrow$$

$$\Rightarrow (p_0 - 1) + \sum_{k=1}^n p_kx^{4k} = (p_0 - 1)^2 + 2(p_0 - 1) \sum_{k=1}^n p_kx^{2k} + \left[\sum_{k=1}^n p_kx^{2k} \right]^2. \quad (2)$$

Bu tenglikning ikkala tomonidagi ozod hadlarni taqqoslab,

$$p_0 - 1 = (p_0 - 1)^2 \Rightarrow p_0 = 1 \text{ yoki } p_0 = 2 \text{ ekanligini ko'ramiz.}$$

Dastlab $p_0 = 1$ holni qaraymiz. Bu holda (2) tenglik quyidagi ko'rinishga keladi [4]:

$$\sum_{k=1}^n p_k x^{4k} = \left[\sum_{k=1}^n p_k x^{2k} \right]^2 = \sum_{k,j=1}^n p_k p_j x^{2(k+j)}. \quad (3)$$

Bu tenglikni ikkala tomonidagi x darajalari oldidagi koeffisientlarni tenglashtirib, noma'lum p_k , $k=1,2,\dots,n$, koeffisientlar uchun quyidagi tenglamalarga ega bo'lamiz:

$$x^{4n} : p_n^2 = p_n (p_n \neq 0) \Rightarrow p_n = 1; x^{4n-2} : 2p_{n-1}p_n = 0 \Rightarrow p_{n-1} = 0;$$

$$x^{4n-4} : 2p_{n-2}p_n + p_{n-1}^2 = p_{n-1} \Rightarrow p_{n-2} = 0;$$

$$x^{4n-6} : 2(p_{n-3}p_n + p_{n-2}p_{n-1}) = 0 \Rightarrow p_{n-3} = 0; \dots$$

Bu jarayonni davom ettirib, $p_k=0$, $k=1,2,\dots,n-1$, ekanligini topamiz.

Demak, $p_0=1$ holda (1) ko'phad $P(x)=x+x^{2n+1}$ (*) ko'rinishda bo'ladi.

Endi $p_0=2$ holni qaraymiz. Bu holda (2) tenglik quyidagi ko'rinishga keladi:

$$\sum_{k=1}^n p_k x^{4k} = 2 \sum_{k=1}^n p_k x^{2k} + \left[\sum_{k=1}^n p_k x^{2k} \right]^2. \quad (4)$$

Bu tenglikning chap tomonidagi x ning eng kichik darajasi x^4 , o'ng tomonda esa x^2 . Bundan $p_1=0$ ekanligi kelib chiqadi. Bu holda (4) tenglik quyidagi ko'rinishga keladi:

$$\sum_{k=2}^n p_k x^{4k} = 2 \sum_{k=2}^n p_k x^{2k} + \left[\sum_{k=2}^n p_k x^{2k} \right]^2. \quad (5)$$

Bu tenglikning chap tomonidagi x ning eng kichik darajasi x^8 , o'ng tomonda esa x^4 . Bundan $p_2=0$ ekanligi kelib chiqadi. Bu holda (5) tenglik quyidagi ko'rinishga keladi:

$$\sum_{k=3}^n p_k x^{4k} = 2 \sum_{k=3}^n p_k x^{2k} + \left[\sum_{k=3}^n p_k x^{2k} \right]^2 \Rightarrow p_3 = 0. \quad (6)$$

Bu jarayonni davom ettirib

$$\sum_{k=n-1}^n p_k x^{4k} = 2 \sum_{k=n-1}^n p_k x^{2k} + \left[\sum_{k=n-1}^n p_k x^{2k} \right]^2 \Rightarrow p_{n-1} = 0;$$

$$p_n x^{4n} = 2p_n x^{2n} + p_n x^{4n} \Rightarrow p_n = 0$$

natijani olamiz. Demak, bu holda $P(x)=2x$. Bu natija (*) ko'phaddan $n=0$ holda kelib chiqadi. Tekshirish orqali $P(x)=x$ birhad ham masala yechimi bo'lishini ko'rish mumkin.

Demak, birinchi holda masala yechimi $P(x)=x+x^{2n+1}$ ($n=0,1,2,\dots$), $P(x)=x$ ko'rinishda bo'ladi [7].

Ikkinchi $P(x)-P(-x)=4x$ holda $P(x)=\sum_{k=0}^m q_k x^k$ deb olsak, unda

$$P(x)-P(-x)=\sum_{k=0}^m q_k x^k - \sum_{k=0}^m q_k (-x)^k = 2[q_1 x + q_3 x^3 + q_5 x^5 + \dots] = 4x \Rightarrow$$

$$q_1 = 2, q_3 = q_5 = \dots = 0 \Rightarrow P(x) = 2x + \sum_{k=0}^n p_k x^{2k}. \quad (7)$$

Bu holda masala shartidan quyidagi tenglikka ega bo'lamiz:

$$\begin{aligned} P(x^2) + x[4P(x) - 4x] &= [P(x)]^2 + 2x^2 \Rightarrow P(x^2) - 2x^2 = [P(x)]^2 - 4xP(x) + 4x^2 \Rightarrow \\ \Rightarrow P(x^2) - 2x^2 &= [P(x) - 2x]^2 \Rightarrow \sum_{k=0}^n p_k x^{4k} = \left[\sum_{k=0}^n p_k x^{2k} \right]^2 = \sum_{k,j=0}^n p_k p_j x^{2(k+j)}. \end{aligned} \quad (8)$$

(8) tenglik ustida (3) tenglikdagi singari mulohazalar yuritib, $p_n = 1$, $p_k = 0$ ($k=0,1,\dots,n-1$)

natijaga kelamiz. Demak, ikkinchi holda masala javobi $P(x)=2x+x^{2n}$, $n=0,1,2,3,\dots$, ko'rinishda bo'lar ekan.

Foydalanilgan adabiyotlar

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Yulchiyeva Zulfizar Nadjibullayevna
TDTU "Pedagogika va Psixologiya" kafedrası
mudiri, dotsent

YANGI O‘ZBEKISTON DEMOKRATIK O‘ZGARISHLAR JARAYONIDA "KASBIY PSIXOLOGIYA" FANINING O‘RNI

Maqolada kasbiy psixologiya fanining texnika yo‘nalishidagi oliy ta‘lim muassasalari o‘qitilishining ahamiyati haqida bayon qilinadi. Talabalarga kasb klassifikatsiyasi, kasblar olamida to‘g‘ri mo‘ljall olish hamda bo‘ljak kasbga psixologik moslashishlari borasidagi bilim, ko‘nikma va malakalarni egallashda kasbiy psixologiya fanining zarurati yoritilgan.

Kalit so‘z va iboralar: Psixologiya, kasbiy psixologiya, kasb, mehnat samaradorligi, ishlab chiqarish, mutaxassislik, shaxs, professiogramma, psixogramma, adaptatsiya. Роль профессиональной психологии в процессе демократических перемен в новом узбекистане.

В статье описывается важность обучения в высших учебных заведениях по техническому направлению учебной дисциплины «Профессиональная психология». Подчеркнута необходимость науки «Профессиональная психология» в приобретении у студентов знаний, умений и навыков по классификации профессий, постановке правильных целей в мире профессий, психологической адаптации к будущей профессии.

Ключевые слова и фразы: психология, профессиональная психология, профессия, производительность труда, производство, специальность, личность, профессиограмма, психограмма, адаптация.

The role of professional psychology in the process of democratic changes in the new uzbekistan.

The article describes the importance of studying in higher educational institutions in the technical direction of the academic discipline "Professional Psychology". The necessity of the science "Professional psychology" in acquiring knowledge, skills and abilities from students in the classification of professions, setting the right goals in the world of professions, and psychological adaptation to the future profession is emphasized.

Key words and phrases: psychology, professional psychology, profession, labor productivity, production, specialty, personality, professiogram, psychogram, adaptation.

Davlat va jamiyat hayotida ro‘y berayotgan tub o‘zgarish va islohotlarning muvaffaqiyatli amalga oshirilishi, avvalo, bozor iqtisodiyoti sharoitida mustahkam bilimga ega, O‘zbekistonning bugungi tashqi va ichki siyosati yo‘nalishlarini tushunadigan, tahlil eta oladigan yosh va tashabbuskor kadrlarni taqozo etadi.

2021-yil 17-avgust kuni O‘zbekiston Respublikasi Prezidenti Shavkat Mirziyoyevning “Yangi O‘zbekiston” gazetasi bosh muharriri Salim Doniyorov savollariga javoblari yuzasidan

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