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ANIQ INTEGRALNING TATBIQLARI. TAQRIBIY HISOBLASH USULLARI

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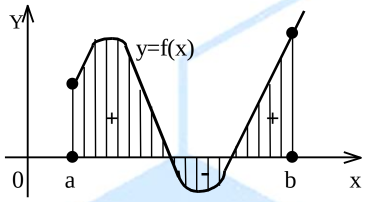
Annotatsiya:*Ushbu maqolada aniq Intergralning tatbiqlari va hisoblash usullari haqida ma'lumotlar berilgan.*

Kalit so'zlar: Intergral,dekart koordinatalar sistemasi,kesma,funksiya Dekart koordinatalar tekisligida yuzalarni hisoblash

Avvalgi bobdan ma'lumki, agar $[a, b]$ kesmada funktsiya $f(x)\geq 0$ bo'lsa, u holda $y=f(x)$ egri chiziq, OX o'qi va $x=a$ hamda $x=b$ to'g'ri chiziqlar bilan chegaralangan egri chiziqli trapetsiyaning yuzi $S=\int_a^b f(x)dx$ (1)

ga teng edi. Agar $[a, b]$ kesmada $f(x)\leq 0$ bo'lsa, u holda aniq integral $\int_a^b f(x)dx \leq 0$ bo'ladi. Absolyut qiymatiga ko'ra bu integralning qiymati ham tegishli egri chiziqli trapetsiyaning yuziga teng: $S=\left|\int_a^b f(x)dx\right|$ (1′)



Agar $f(x)$ funktsiya $[a, b]$ kesmada ishorasini chekli son marta o'zgartirsa, u holda integralni butun $[a, b]$ kesmada qismiy kesmachalar bo'yicha integrallar yig'indisiga ajratamiz. $f(x)>0$ bo'lgan kesmalarda integral musbat, $f(x)<0$ bo'lgan kesmalarda integral manfiy bo'ladi. Butun kesma bo'yicha olingan integral OX o'qidan yuqorida va pastda yotuvchi shakllar yuzining tegishli algebraik yig'indisini beradi (99-rasm). Yuzalar yig'indisini odatdagi ma'noda hosil qilish uchun yuqorida ko'rsatilgan kesmalar bo'yicha olingan integrallar absolyut qiymatlari yig'indisini topish yoki

$S=\int_a^b |f(x)|dx$ (1′′‖) integralni hisoblash kerak.

Agar $y_1=f_1(x)$ va $y_2=f_2(x)$ egri chiziqlar hamda $x=a$ va $x=b$ to'g'ri chiziqlar bilan chegaralangan shaklning yuzini hisoblash kerak bo'lsa, u holda $f_1(x)\geq f_2(x)$ shart

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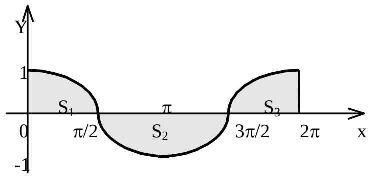
bajarilgan shaklning yuzi quyidagiga teng: $S=\int_a^b (f_1(x)-f_2(x))dx$.

(2)

1-*misol*. *y*=cos*x*, *y*=0 chiziqlar bilan chegaralangan shaklning yuzi hisoblansin,



bunda *x*∈[0,2π].

Yechish. *x*∈[0,π/2] va *x*∈[3π/2,2π] da cos*x*≥0 hamda *x*∈[π/2,3π/2] da cos*x* ≤ 0 bo'lgani uchun

$$S=\int_0^{2\pi}|\cos x|\,dx=\int_0^{\pi/2}\cos x dx+\left|\int_{\pi/2}^{3\pi/2}(-\cos x)dx\right|+$$

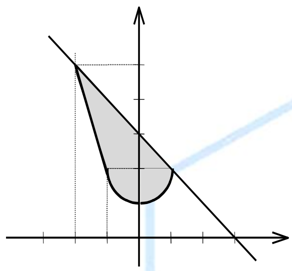
$$+\int_{3\pi/2}^{2\pi}\cos x dx=\sin x|_0^{\pi/2}+|\sin x||_{\pi/2}^{3\pi/2}+\sin x|_{3\pi/2}^{2\pi}=\sin\frac{\pi}{2}-$$

$$-\sin 0+\left|\sin\frac{3\pi}{2}-\sin\frac{\pi}{2}\right|+\sin 2\pi-\sin\frac{3\pi}{2}=1+|-1-1|-(-1)=4$$

Demak, s=4(kv. birlik) ekan.

2-*misol*. $y=x^2+1$ va *y*=3-*x* chiziqlar bilan chegaralangan sohaning yuzini hisoblang.

Yechish. Shaklni yasash uchun avval ushbu $\begin{cases} y=x^2+1 \\ y=3-x\end{cases}$ sistemani yechib, chiziqlarning kesishish nuqtalarini topamiz.



Bu chiziqlar *A* (–2;5) va *V* (1;2) nuqtalarda kesishadi. U holda

$$S=\int_{-2}^{1}(3-x)dx-\int_{-2}^{1}(x^2+1)dx=\int_{-2}^{1}(2-x-x^2)dx=$$

$$=(2x-\frac{x^2}{2}-\frac{x^3}{3})|_{-2}^{1}=(2-\frac{1}{2}-\frac{1}{3})-(-4-\frac{4}{2}+\frac{8}{3})=\frac{9}{2}(кв.бирл.).$$

Endi, tenglamasi *x*=φ(*t*), *y*=ψ(*t*) parametrik ko'rinishda berilgan chiziq bilan chegaralangan egri chiziqli trapetsiyaning yuzasini hisoblaymiz. Faraz qilaylik, bu tenglamalar [*a*, *b*] kesmada biror *u*=*f*(*x*) funktsiyani aniqlasin, bunda $t\in[\alpha,\beta]$ va $\varphi(\alpha)=a$, $\varphi(\beta)=b$.

U holda egri chiziqli trapetsiyaning yuzini $S=\int_a^b ydx$ formula bo'yicha hisoblanish mumkin. Bu integralda o'zgaruvchini almashtiramiz: $x=\varphi(t)$, $dx=\varphi'(t)\,dt$, $y=f(x)=f(\varphi(t))=\psi(t)$.

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Demak,

$$S=\int_{\alpha}^{\beta}\psi(t)\varphi'(t)dt \qquad (3)$$

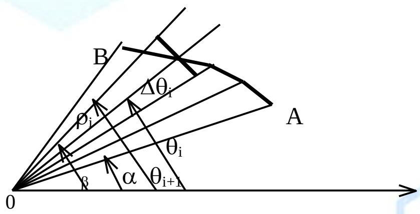
3-*misol*. $x=a\cos t$, $y=b\sin t$ ellips bilan chegaralangan sohaning yuzi hisoblansin.

Yechish. Ellipsning yuqori yarim yuzini hisoblab, uni 2 ga ko'paytiramiz. $-a\le x\le +a$ uchun $-a=a\cos t$, $\cos t=-1$, $t=\pi$; $a=a\cos t$, $\cos t=1$, $t=0$

$$S=2\int_{\pi}^{0}b\sin t(-a\sin tdt)=-2ab\int_{\pi}^{0}\sin^2 tdt=\pi ab.$$

1.2. Tekis shakllar yuzini qutb koordinatalarda hisoblash

AB egri chiziq qutb koordinatalarida $\rho=f(\theta)$ formula bilan berilgan va $f(\theta)$ funktsiya $[\alpha,\beta]$ kesmada uzluksiz bo'lsin.



Ushbu $\rho=f(\theta)$ egri chiziq va qutb o'qlari hamda α va β burchak hosil qiluvchi ikkita $\varphi=\alpha, \varphi=\beta$ nurlar bilan chegaralangan egri chiziqli sektorning yuzini aniqlaymiz. Buning uchun berilgan yuzani $\alpha=\theta_0, \theta=\theta_1,\ldots,\theta=\theta_i,\ldots,\theta_n=\beta$ nurlar bilan n ta ixtiyoriy qismga bo'lamiz. O'tkazilgan nurlar orasidagi burchaklarni $\Delta\theta_1,\Delta\theta_2,\ldots,\Delta\theta_n$ bilan belgilaymiz. θ_{i-1} bilan θ_i orasidagi biror $\overline{\theta_i}$ burchakka mos nurning uzunligini $\overline{\rho_i}$ orqali belgilaymiz. Radiusi $\overline{\rho_i}$ va markaziy burchagi $\Delta\theta_i$ bo'lgan doiraviy sektorni qaraymiz. Uning yuzi $\Delta S_i=\frac{1}{2}\overline{\rho_i^2\Delta\theta_i}$ bo'ladi.

Ushbu yig'indi

$$S_n=\frac{1}{2}\sum_{i=1}^{n}\overline{\rho_i^2}\Delta\theta_i=\frac{1}{2}\sum_{i=1}^{n}[f(\overline{\theta_i})]^2\Delta\theta_i$$

zinapoyasimon sektorning yuzini beradi.

Bu yig'indi $\alpha\le\theta\le\beta$ kesmada $\rho^2=[f(\theta)]^2$ funktsiyaning integral yig'indisi bo'lgani sababli uning limiti $\max\Delta\theta_i\to 0$ da $\frac{1}{2}\int_{\alpha}^{\beta}\rho^2 d\theta$ aniq integralga teng. Bu $\Delta\theta_i$ burchak ichida qanday ρ_i nur olishimizga bog'liq emas. Demak, *OAV* sektorning yuzi:

$$S=\frac{1}{2}\int_{\alpha}^{\beta}\rho^2 d\theta=\frac{1}{2}\int_{\alpha}^{\beta}[f(\theta)]^2 d\theta\,. \qquad (4)$$

4-*misol*. $\rho=a(1+\cos\theta)$, $a>0$ kardioida bilan chegaralangan figuraning yuzini hisoblang.

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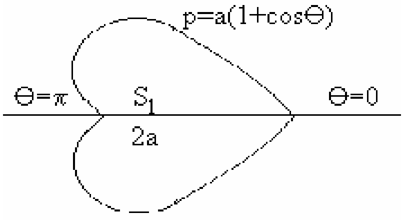


$$S = 2S_1 = 2\frac{1}{2}\int_{\alpha}^{\beta}\rho^2 d\theta = \int_{\alpha}^{\beta}\rho^2 d\theta,$$

$$S = \int_0^{\pi} a^2(1+\cos\theta)^2 d\theta = a^2\int_0^{\pi}(1+2\cos\theta+\cos^2\theta)d\theta =$$

$$= a^2\int_0^{\pi}\left(\frac{3}{2}+2\cos\theta+\frac{1}{2}\cos 2\theta\right)d\theta = a^2\left(\frac{3}{2}\theta+2\sin\theta+\right.$$

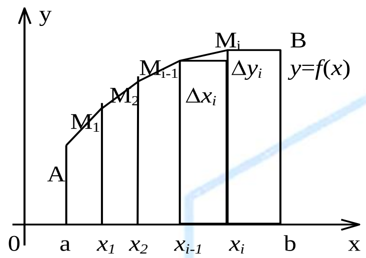
$$\left.+\frac{1}{4}\sin 4\theta\right)\Big|_0^{\pi} = \frac{3}{2}\pi a^2; S = \frac{3}{2}\pi a^2 (kv.birl.)$$

2-§. Egri chiziq yoyining uzunligi

2.1. Yoy uzunligini dekart koordinatalar sistemasida hisoblash

To'g'ri burchakli dekart koordinatalar tekisligida egri chiziq $u=f(x)$ tenglama bilan berilgan bo'lsin.

Bu egri chiziqning $x=a$ va $x=b$ vertikal to'g'ri chiziqlar orasidagi AB yoyining uzunligini topamiz.



104-rasm.

AB yoyda abstsissalari $a=x_0$, x_1, x_2,..., x_i,..., $x_n=b$ bo'lgan A, M_1, M_2,..., M_i,..., B nuqtalarni olamiz va AM_1, M_1M_2,..., $M_{n-1}B$ vatarlarni o'tkazamiz, ularning uzunliklarini mos ravishda $\Delta S_1,\Delta S_2,...,\Delta S_n$ bilan belgilaymiz.

AB yoy ichiga chizilgan siniq chiziqning uzunligi $S_n = \sum_{i=1}^{n}\Delta S_i$ bo'lgani uchun AB yoyning uzunligi

$$S = \lim_{\max\Delta S_i\to 0}\sum_{i=1}^{n}\Delta S_i \qquad (1)$$

Faraz qilaylik, $f(x)$ funktsiya va uning $f'(x)$ hosilasi $[a, b]$ kesmada uzluksiz bo'lsin. U holda

$$\Delta S_i = \sqrt{(\Delta x_i)^2+(\Delta y_i)^2} = \sqrt{1+\left(\frac{\Delta y_i}{\Delta x_i}\right)^2}\cdot\Delta x_i$$

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yoki Lagranj teoremasiga asosan $\frac{\Delta y_i}{\Delta x_i}=\frac{f(x_i)-f(x_{i-1})}{x_i-x_{i-1}}=f'(\xi_i)$,

bunda $x_{i-1}<\xi_i<x_i$ bo'lgani uchun $\Delta S_i=\sqrt{1+(f'(\xi_i))^2}\Delta x_i$

bo'ladi. Ichki chizilgan siniq chiziqning uzunligi esa $S_n=\sum_{i=1}^{n}\sqrt{1+(f'(\xi_i))^2}\Delta x_i$.

Shartga ko'ra, $f(x)$ funktsiya uzluksiz, demak, $\sqrt{1+(f'(x))^2}$ funktsiya ham uzluksizdir. Shuning uchun integral yig'indining limiti mavjud va u quyidagi aniq integralga teng:

$$S=\lim_{\max\Delta x_i\to 0}\sum_{i=1}^{n}\sqrt{1+(f'(\xi_i))^2}\Delta x_i=\int_a^b\sqrt{1+(f'(x))^2}dx.$$

Demak, yoy uzunligini hisoblash formulasi: $S=\int_a^b\sqrt{1+(f'(x))^2}dx=\int_a^b\sqrt{1+(\frac{dy}{dx})^2}dx$ (2)

ekan.

Endi egri chiziq tenglamasi

$$x=\varphi(t),\ y=\psi(t),\ \alpha\le t\le\beta \tag{3}$$

parametrik ko'rinishda berilgan bo'lsin, bunda $\varphi(t)$ va $\psi(t)$ uzluksiz hosilali uzluksiz funktsiyalar va $\varphi^1(t)$ berilgan oraliqda nolga aylanmaydi.

Bu holda (3) tenglama biror $u=f(x)$ funktsiyani aniqlaydi. Bu funktsiya uzluksiz bo'lib, $\frac{dy}{dx}=\frac{\psi'(t)}{\varphi'(t)}$ uzluksiz hosilaga ega. $a=\varphi(\alpha)$, $b=\varphi(\beta)$ bo'lsin. (2) integ-ralda $x=\varphi(t)$, $dx=\varphi'(t)\,dt$ almashtirish bajaramiz. U holda

$$S=\int_\alpha^\beta\sqrt{1+(\frac{\psi'(t)}{\varphi'(t)})^2}\cdot\varphi'(t)dt \quad \text{ёки} \quad S=\int_\alpha^\beta\sqrt{(\varphi'(t))^2+(\psi'(t))^2}dt. \tag{4}$$

Agar egri chiziq fazoda $x=\varphi(t),\ y=\psi(t),\ z=\chi(t)$ (5)
parametrik tenglamalar bilan berilgan va $\varphi(t)$, $\psi(t)$, $\chi(t)$ funktsiyalar $[\alpha,\beta]$ kesmada uzluksiz hamda uzluksiz hosilalarga ega bo'lsa, egri chiziq aniq limitlarga ega bo'ladi va u

$S=\int_\alpha^\beta\sqrt{(\varphi'(t))^2+(\psi'(t))^2+(\chi'(t))^2}dt$ (6) formula bilan aniqlanadi.

2.2. Yoy uzunligini qutb koordinatalar sistemasida hisoblash

Qutb koordinatalar sistemasida egri chiziqning tenglamasi

$$\rho=f(\theta) \tag{7}$$

bo'lsin. Qutb koordinatalaridan Dekart koordinatalariga o'tish formulasi: $x=\rho\cos\theta$, $y=\rho\sin\theta$ yoki (7) dan foydalansak:

$$x=f(\theta)\cos\theta,\ y=f(\theta)\sin\theta.$$

Bu tenglamalarga egri chiziqning parametrik tenglamalari deb qarab, yoy uzunligini hisoblash uchun (4) formulani tatbiq qilamiz:

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$$\frac{dx}{d\theta}=f'(\theta)\cos\theta-f(\theta)\sin\theta,\quad \frac{dy}{d\theta}=f'(\theta)\sin\theta+f(\theta)\cos\theta.$$

U holda $\quad (\frac{dx}{d\theta})^2+(\frac{dy}{d\theta})^2=(f'(\theta))^2+(f(\theta))^2=\rho'^2+\rho^2.$

Demak, $\quad S=\int_{\theta 0}^{\theta 1}\sqrt{\rho'^2+\rho^2}\,d\theta. \qquad (8)$

1-*misol*. $x^2+u^2=r^2$ aylana uzunligi hisoblansin.

Yechish. Dastlab aylananing 1-chorakda yotgan to'rtdan bir qismining uzunligini hisoblaymiz. U holda *AV* yoyning tenglamasi

$$y=\sqrt{r^2-x^2},\quad \frac{dy}{dx}=-\frac{x}{\sqrt{r^2-x^2}};$$

$$\frac{1}{4}S=\int_0^r\sqrt{1+\frac{x^2}{r^2-x^2}}dx=\int_0^r\frac{r}{\sqrt{r^2-x^2}}dx=r\cdot\arcsin\frac{x}{2}\Big|_0^2=r\cdot\frac{\pi}{2};$$

Butun aylananing uzunligi: $S=2\pi r$;

2-*misol*. ρ=*a* (1+cosθ) kardioidaning uzunligi topilsin. Kardioida qutb o'qiga nisbatan simmetrikdir. θ qutb burchagini 0 dan π gacha o'zgartirib, izlanayotgan uzunlikning yarmini topamiz (103-rasm). (8) formuladan foydalanamiz, bunda

$$\rho'=-a\sin\theta$$

$$S=2\cdot\int_0^\pi\sqrt{a^2(1+\cos\theta)^2+a^2\sin^2\theta}\,d\theta=2a\int_0^\pi\sqrt{2+2\cos\theta}\,d\theta=$$

$$=4a\cdot\int_0^\pi\cos\frac{\theta}{2}d\theta=8a\cdot\sin\frac{\theta}{2}\Big|_0^\pi=8a\cdot 1=8a.$$

3-*misol*. $x=a\cos t$, $y=b\sin t$, $0\le t\le 2\pi$, ellipsning uzunligi hisoblansin, bunda $a>b$.

Yechish. (4) formuladan foydalanamiz. Avval yoy uzunligining 1/4 qismini hisoblaymiz.

$$\frac{S}{4}=\int_0^{\pi/2}\sqrt{a^2\sin^2 t+b^2\cos^2 t}\,dt=\int_0^{\pi/2}\sqrt{a^2(1-\cos^2 t)+b^2\cos^2 t}\,dt=$$

$$=\int_0^{\pi/2}\sqrt{a^2-(a^2-b^2)\cos^2 t}\,dt=a\int_0^{\pi/2}\sqrt{1-\frac{a^2-b^2}{a}\cos^2 t}\,dt=$$

$$=a\int_0^{\pi/2}\sqrt{1-k^2\cos^2 t}\,dt$$

bunda $k=\frac{\sqrt{a^2-b^2}}{a}<1$. Demak, $S=4a\int_0^{\pi/2}\sqrt{1-k^2\cos^2 t}\,dt$.

3-§. Aniq integralning jism hajmlarini hisoblashga qo'llanilishi

3.1. Jism hajmini parallel kesimlar yuzalari bo'yicha hisoblash

Biror *T* jism berilgan bo'lsin. Bu jismni *OX* o'qqa perpendikulyar tekislik bilan kesishdan hosil bo'lgan har qanday kesimning yuzi ma'lum, deb faraz qilamiz. Bu holda yuza kesuvchi tekislikning vaziyatiga bog'liq, ya'ni x ning funktsiyasi bo'ladi:

$$Q=Q(x)$$

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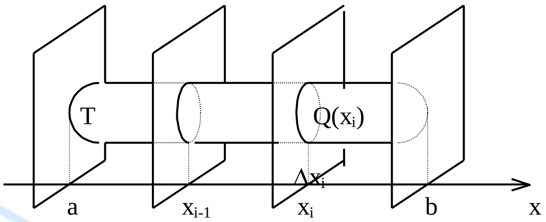

105-rasm.

$Q(x)$ ni uzluksiz funktsiya, deb faraz qilib, berilgan jism hajmini aniqlaymiz.

$X=x_0=a$, $x=x_1$, $x=x_2,\ldots$, $x=x_n=b$ tekisliklarni o'tkazamiz. Har bir $x_{i-1}\le x\le x_i$ qismiy oraliqda ixtiyoriy ξ_I nuqta tanlab olamiz va I ning har bir qiymati uchun yasovchisi x o'qiga parallel bo'lib, yo'naltiruvchisi T jismni $x=\xi_I$ tekislik bilan kesishdan hosil bo'lgan kesimning konturidan iborat bo'lgan tsilindrik jism yasaymiz. Asosining yuzi $Q(\xi_i)$ va balandligi Δx_i bo'lgan bunday elementar tsilindrning hajmi $Q(\xi_i)\Delta x_i$ ga teng. Hamma tsilindrlarning hajmi $v_n=\sum_{i=1}^{n}Q(\xi_i)\Delta x_i$ bo'ladi.

Bu yig'indining $\max\Delta x_i\to 0$ dagi limiti berilgan jismning hajmi, deyiladi: $V=\lim_{\max\Delta x_i\to 0}\sum_{i=1}^{n}Q(\xi_i)\Delta x_i$.

V_n miqdor $[a, b]$ kesmada uzluksiz $Q(x)$ funktsiyaning integral yig'indisidir, shuning uchun limit mavjud va u $V=\int_a^b Q(x)dx$ (1)

aniq integral bilan ifodalanadi.

Misol. $\frac{x^2}{a^2}+\frac{y^2}{b^2}+\frac{z^2}{c^2}=1$ ellipsoidning hajmi hisoblansin.

Yechish. Ellipsoidni OYZ tekislikka parallel bo'lib undan x masofa uzoqlikdan o'tgan tekislik bilan kesganda yarim o'qlari

$b_1=b\sqrt{1-\frac{x^2}{a^2}}$, $c_1=c\sqrt{1-\frac{x^2}{a^2}}$ bo'lgan $\frac{y^2}{(b\sqrt{1-\frac{x^2}{a^2}})^2}+\frac{z^2}{(c\sqrt{1-\frac{x^2}{a^2}})^2}=1$ ellips hosil bo'ladi. Bu ellipsning

yuzi: $Q(x)=\pi b_1c_1==\pi bc\,(1-x^2/a^2)$.

Ellipsoidning hajmi: $v=\pi bc\int_{-a}^{a}(1-\frac{x^2}{a^2})dx=\pi bc(x-\frac{x^3}{3a^2})|_{-a}^{a}=\frac{4}{3}\pi abc(kub.birl.)$.

3.2. Aylanma jismning hajmi

$y=f(x)$ egri chiziq Ox o'q va $x=a$, $x=b$ to'g'ri chiziqlar bilan chegaralangan egri chiziqli trapetsiyaning OX o'qi atrofida aylanishidan hosil bo'lgan jismni qaraylik. Bu jismni abstsissalar o'qiga perpendikulyar tekislik bilan kesishdan hosil bo'lgan ixtiyoriy kesim doira bo'ladi. Uning yuzi $Q=\pi y^2=\pi(f(x))^2$.

Hajmni hisoblashning (1) umumiy formulasini tatbiq etib, aylanma jismning hajmini hisoblash formulasini hosil qilamiz: $v=\pi\int_a^b y^2dx=\pi\int_a^b (f(x))^2dx$. (2)

Misol. $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ ellipsni OX va OY o'qlari atrofida aylantirish natijasida hosil qilingan jismlarning hajmlarini hisoblang.

Yechish. Ellips tenglamasidan: $y^2=\frac{b^2}{a^2}(a^2-x^2)$; $x^2=\frac{a^2}{b^2}(b^2-y^2)$

Ellipsni OX o'qi atrofida aylantirishdan hosil bo'lgan jismning hajmi:

$$V=2V_1=2\pi\int_0^a y^2dx=2\pi\frac{b^2}{a^2}\int_0^a (a^2-x^2)dx=2\pi\frac{b^2}{a^2}(a^2x-\frac{x^3}{3})|_0^a=$$

$$=2\pi\frac{b^2}{a^2}(a^3-\frac{a^3}{3})=\frac{4}{3}\pi ab^2;\quad V=\frac{4}{3}\pi ab^2(kub.birl.).$$

Ellipsni OY o'qi atrofida aylantirishdan hosil bo'lgan jismning hajmi:

$$V=2V_1=2\pi\int_0^b x^2dy=2\pi\frac{a^2}{b^2}\int_0^b (b^2-y^2)dy=2\pi\frac{a^2}{b^2}(b^2y-\frac{y^3}{3})|_0^b=$$

$$=2\pi\frac{a^2}{b^2}(b^3-\frac{b^3}{3})=\frac{4}{3}\pi a^2b;\quad V=\frac{4}{3}\pi a^2b(kub.birl.).$$

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Aniq integral. Test–1

1. $\int_0^1 x^{90}\,dx$ nechaga teng?

A) 1 B) 91 C) $\frac{1}{89}$ D) $\frac{1}{90}$ E) $\frac{1}{91}$

2. $\int_2^5 x^2\,dx$ nechaga teng?

A) 35 B) 36 C) 37 D) 38 E) 39

3. $\int_0^1 (x^2+e^x)\,dx$ nechaga teng?

A) $\frac{2}{3}$+e B) $\frac{1}{3}$+e C) 1+e

D) $-\frac{1}{3}$+e E) $-\frac{2}{3}$+e

4. $\int_0^1 (x^2+4x)^3(x+2)\,dx$ nechaga teng?

A) $\frac{25}{2}$ B) $\frac{125}{16}$ C) $\frac{125}{4}$ D) $\frac{625}{8}$ E) $\frac{25}{4}$

5. $\int_0^2 (x^2-x)^4\cdot(2x-1)\,dx$ nechaga teng?

A) $2x^3-5y^2$ B) $5x^3+y^2$ C) x^3+21y^2

D) x^3-y^2 E) $3x^3-4y^2$

18. $\int_2^{e+1}\frac{x+2}{x-1}dx$ nechaga teng?

A) e B) e–1 C) e–2 D) e+2 E) e+1

19. $\frac{m}{n}$=e$\sqrt{e}$ bo\`lsa, $\int_m^n \frac{1}{x}dx$ nechaga teng?

A) $\frac{3}{2}$ B) $-\frac{3}{2}$ C) $\frac{2}{3}$ D) $-\frac{2}{3}$ E) $\frac{1}{3}$

20. $\int_3^9 f(x)\,dx$=24 bo\`lsa, $\int_1^3 f(3x)\,dx$ nechaga teng?

A) 8 B) 24 C) 36 D) 48 E) 72

21. $\int_0^1 (2x+1)\cdot e^{x^2+x+1}\,dx$ nechaga teng?

A) e^3 B) e^3-e C) e^2+1 D) e^2-e E) e^3-1

22. $\int_1^e \frac{dx}{x(1+ln^2x)}$ nechaga teng?

A) 0 B) $\frac{\pi}{4}$ C) $\frac{\pi}{3}$ D) $\frac{\pi}{6}$ E) $\frac{2\pi}{3}$

23. $\int_4^a \frac{xdx}{\sqrt{x^2-15}} = 6$ bo\`lsa, a nechaga teng?

A) 1 B) 2 C) 6 D) 8 E) 10

24. $\int_{-1}^0 \sqrt{1+t^4}t^3\,dt$ nechaga teng?

A) $\frac{\sqrt{2}}{6}$ B) $1-2\sqrt{2}$ C) $\frac{1+\sqrt{2}}{6}$ D) $\frac{1}{6}$ E) $\frac{1-2\sqrt{2}}{6}$

25. $\int_e^{e^2}\frac{dx}{x(lnx)^2}$ nechaga teng?

A) $\frac{3}{2}$ B) $\frac{2}{3}$ C) $\frac{1}{2}$ D) $-\frac{1}{2}$ E) $\frac{3}{4}$

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