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GEPERBOLIK TIPDAGI DIFFERENSIAL TENGLAMA UCHUN GURSA MASALASI

Annotasiya: Aralash tipdagi differensial tenglamalar o’zining mexanika, fizika, biologiya, texnikaning turli sohalariga amaliy tadbiqlari orqali differensial tenglamalar sohasining muhim sohasiga ega.

Ayniqsa Frankl Lavrent’ev bitsadze tenglamasi uchun Frikomi masalasining gaz dinamikasiga tadbiqlarini topgandan keyin bu sohaga qiziqish kuchaydi.

Hozirgi zamon texnikasining tez rivojlanishi tabiiy fanlar oldida yangi vazifalar qo’ya boshladi. Ayniqsa matematikaga, shu jumladan oddiy differensial tenglamalar, xususiy hosila differensial tenglamalarga texnik masalalarni yechish uchun yangi-yangi chegaraviy masalalarni yechish usulari takomillashtirish va uning amaliy tadbiqlarini ta’minlash kabi talablarni qo’ydi.

Differensial tenglamalarga keltirilgan fizik, mexanik, texnik masalalardan tashqari ekologiya, biologiya, meditsina, kimyo va boshqa fanlarning ham amaliy masalalarni differensial tenglamalarga keltirish va ular uchun konkret chegaraviy masalalarni o’rganish zarurati dolzarb bo’lib qoldi.

Ayniqsa yuqorida aytilgan masalalarni yechishda matematik-fizika tenglamalari fanining yangi sohasi aralash tipdagi masalalarni o’rganish respublikamizda yetakchi matematiklarimiz rahbarligida yuqori darajada rivoj topgan.

Matematik fizika tenglamalari darsliklardan ma’lumki xususiy hosilali tiplarga bo’lib o’rganiladi. Ular eliptik, giperbolik, parabolic tipdagi masalalardir.

F.I.Frankl Lavrent’ev-Bitsadze tenglamasining gaz dinamikasiga tadbiqlarini o’rganadi va aniqlaydi. Keyinchalik esa aralash tipdagi tenglamalarning texnikaning ko’p sohalarida tadbiqlari topildi.

Shu sababli aralash tipdagi masalalarni o’rganishga qiziqish kuchaydi.

Tekislikda

$$A(x,y)U_{xx} + 2B(x,y)U_{xy} + C(x,y)U_{yy} + D(x,y)U_x + E(x,y)U_y + F(x,y)U = 0 \quad (1)$$

tenglama biror D R^2 sohada berilgan bo’lsin. Koieffisentlar A,B,C,D,E,F lar x,y larning haqiqiy funksiyalari bo’lib , berilgan D sohada (1) tenglama $B^2 - AC < 0$ bo’lsa eliptik, $B^2 - AC < 0$ bo’lsa giperbolik, $B^2 - AC = 0$ bo’lsa parabolic tipga tegishli bo’ladi. Biroq bu uchta tip umumiy holda tekislikka ikkinchi tartibli xususiy hosila tenglamalarning barchasini tiplarga bo’linishi tugamaydi, chunki $B^2 - AC$ ifoda D sohada o’z ishorasini saqlamasligi mumkin. Agar $B^2 - AC$ D sohada o’z ishirasini o’zgartirsa (1) tenglama D sohalarda aralash tipdagi tenglama deyilad.

D sohani γ chiziq D_1 va D_2 sohalarga bo'lib, (1) tenglama D_1 sohada eliptik, D_2 sohada giperbolik, γ chiziqda parabolik tipga tegishli bo'lsa γ chiziqqa tipning buzilish chizig'I deyiladi.

Ma'lumki

$$Ady^2 - 2Bdydx + Cdx^2 = 0 \qquad (2)$$

oddiy differensial tenglama (1) tenglamaning xarakteristik tenglamasi deyiladi va quyidagi ko'rinishda ham yozish mumkin:

$$Ay^{\prime 2} - 2By' + C = 0$$

Bu yerdan

$$\begin{aligned} y_1 &= \frac{B + \sqrt{B^2 - AC}}{A} \\ y_2 &= \frac{B - \sqrt{B^2 - AC}}{A} \end{aligned} \qquad (3)$$

(3) sistema yechimlari

$$\begin{aligned} y_1 &= \xi(x, y) = const \\ y_2 &= \zeta(x, y) = const \end{aligned} \qquad (4)$$

chiziqlar (4) sistemaning xarakteristikalari deyiladi.

Bu yerdan (1) tenglama eliptik bo'lganda ham xarakteristikalari haqiqiy bo'lishi kelib chiqadi.

Ikkinchi tartibli ikki o'zgaruvchili xususiy hosilali aralash tipdagi tenglamalarni quyidagi kanonik tenglamalardan birortasiga keltirish mumkin.

$$y^n U_{xx} + U_{yy} + a_1(x, y)U_x + b_1(x, y)U_y + C_1(x, y)U = f_1(x, y) \qquad (5)$$

$$y^n U_{xx} + U_{xx} + a_2(x, y)U_x + b_2(x, y)U_y + C_2(x, y)U = f_2(x, y) \qquad (6)$$

Odatda (5).(6) tenglamalar mos ravishda birinchi va ikkinchi tur aralash tipdagi tenglamalar deyiladi.

Chegarada buzilmaydigan tenglamalar uchun konkret qo'yilgan chegaraviy masalalar chegarada buziladigan tenglamalar uchun umuman ayniganda konkret qoyilgan chegaraviy masalalar bo'lmay qoladi.

Bu faqat birinchi marta M.V.Keld'ii tomonidan y=0 da buziladigan eliptik tipdagi

$$y^m U_{yy} + U_{xx} + aU_y + bU_x + CU = 0 \qquad (7)$$

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tenglama uchun birinchi chegaraviy masalaning konkret qo'yilishiga *m* va *a(x,0)* – lar ta'sir qilishi va *y=0* buzilish chizig'i ayrim hollarda chegaraviy shartlardan ozod qilinishi aytilgan.

Keyinchalik shunga o'xshash faktlar *y=0* chizig'ida buziladigan ayrim giperbolik tenglamalar uchun ham o'rinli bo'lishi isbotlangan.

Matematik fizika tenglamalariga o'rganiladigan eliptik tipdagi tenglamalar uchun Direxli, Neymanmasalalari, giperbolik tipdagi masalalar uchun Koshi, Darbu, Gursa, Koshi –Gursa masalalari, parabolic tipdagi tenlamalar uchun birinchi, ikkinchi chegaraviy masalalar aralash tipdagi mtenglamalar uchun ham o'rinlidir.

Masalan F.I.Frankl' tomonidan yassi devorli idishdan (idish ichidagi tezlik tovush tezligidan kichik) , tovush tezligidan katta (yuqori) tezlikda otilib chiquvchi oqim to'g'risidagi masala

$$K(y)U_{xx}+U_{yy}=0, \quad K(0)=0, \quad K'(y)>0$$

Chapligin tenlamasi uchun Trikomi masalasiga kelishini ko'rsatadi. Aralash tipdagi tenglamalar samalyotsozlik, raketasozlikda ham keng qo'llanilayapti.

Turli amaliy masalalarni yechishda aralash tipdagi tenglamalarning ahamiyati tobora oshib borayotganini, hamda bu yo'nalishning respublikamizda yuqori darajada rivoj topganini ta'kidlash o'rinli bo'ladi.

Shundan keyin aralash tipdagi differensial tenglama uchun konkret chegaraviy masalalar qoyish va ularni o'rganishga yana qiziqish kuchaydi.

Geperbolik tipdagi differensial tenglama uchun Gursa masalasi.

Quyidagi giperbolik tipdagi xususiy hosilasi differensial tenglama berilgan bo'lsin:

$$\frac{D^2U}{D\xi D\tau}+a(\xi,\ \tau)\frac{Du}{D\xi}+b(\xi,\ \tau)\frac{Du}{D\xi}+c(\xi,\ \tau)u=F(\xi,\ \tau) \qquad (1.1)$$

Malumki har qanday chiziqli ikki o'zgaruvchiga bof'liq ikkinchi tartibli geperbolik tenglamaning (1) kanonik kurinishda yozish mumkin.

(1) yenglamaning xaraktrestikalari.

$\xi=\xi_0=\text{cons}$ $\tau=\tau_0=\text{cons}$ $O\xi$ va $O\tau$ o'qlariga parallel to'g'ri chiziqlardan iborat bo'ladi.

(1) tenglamaing koeffisentlari *a, b, c, F* uzluksiz differensallanuvchi funksiyalar bo'ladi.

Qo'ydagi chegaraviy masalani qo'yamiz.

(1.1) tenglamaning quydagi shartlarni qanoatlantiradigan U(*x, y*) yechimi topilsin.

1. $\begin{matrix}\xi_0 & \xi & a_0\\ \tau_0 & \tau & b_0\end{matrix}$ xaraktrestik to'rtburchakda *U(ξ τ)* funksiya (1) tenglamani qanoatlantiradi.

2. $U/\xi = \xi_0 = \varphi_1(\tau) \quad \tau_0 \quad \tau \quad b_0$ (1.2)

$U/\tau = \tau_0 = \varphi_2(\tau) \quad \xi_0 \quad \xi \quad a_0$

Bu yerda $\varphi_1(\tau)$ $\varphi_2(\tau)$ funksiyalar uzluksiz birinchi tartibli hosilalarga ega bu quyilgan masalaning yehimi mavjud va yagonaligini isbotlaymz shu maqsadda

$$\frac{DU}{D\xi} = v, \qquad \frac{DU}{D\tau} = \omega, \qquad (1.3)$$

belgilashlar kiritib (1) tenglamani

$$\frac{Dv}{D\tau} = \frac{D\omega}{D\xi} = F(\xi, \tau) - av - b\omega - cv \qquad (1.4)$$

Ko'rinishda yozib olamiz.

Bu yerda U(ξ, τ), v(ξ, τ), $\omega(\xi, \tau)$ - funksiyalarga nisbatan qo'ydagicha integral tenglamalar sistemasiga ega bo'amiz.

$$V(\xi, \tau) = v(\xi, \tau_0) + \int_{\tau_0}^{\tau} (F - av - b\omega - cu)d\tau$$

$$\omega(\xi, \tau) = \omega(\xi_0, \tau) \int_{\tau_0}^{\tau} (F - av - b\omega - cu)d\xi$$

$$U(\xi, \tau) = U(\xi, \tau_0) + dr \qquad (1.5)$$

(1.3) belgilashlar yordamida (2) shart quydagicha ko'rinishni oladi.

$$v(\xi, \tau_0) = \left.\frac{Du}{D\xi}\right|_{\tau = \tau_0} = \varphi_2^1(\xi)$$

$\omega(\xi_0, \tau) = \left.\frac{Du}{D\tau}\right|_{\xi = \xi_0} = \varphi_1(\tau)$ u holda (1.4), (1.5) shartlardan quydagi sistemaga ega bo'lamiz.

$$V(\xi, \tau) = \varphi_2^1(\xi) + \int_{\tau_0}^{\tau} (F - av - b\omega - cu)d\tau \ ,$$

$$\omega(\xi, \tau) = \varphi_1^1(\tau) + \int_{\tau_0}^{\tau} (F - av - b\omega - cu)d\xi$$

$$U(\xi,\ \tau)=\varphi_2(\xi)+\int_{\tau}^{\tau}\omega\,dr \qquad (1.6)$$

(1.6) sistemaning yechimlari u, v, ω - lar (1.4) sistemaning ham yechimlari bo'lishini tekshirish qiyin emas. Yani (1.6) sistema (2) shartni qanoatlantruvchi (1) tenglama bilan ekvivalent.

(1.6) sistemani ketma-ket yaqinlahish usuli bilan yechamiz.

Bu uchun nolinchi yaqinlashisharni $v_0=\varphi_2^1(\xi)$, $\omega_0=\varphi_1^1(\tau)$, $u_0=\varphi_2(\xi)$ deb olib *n*-chi yaqinlashishlarni quydagi olamiz .

$$V_n=\varphi_2^1(\xi)+\int_{\tau_0}^{\tau}(F(\xi,\ \tau)-av_{n-1}-b\omega_{n-1}-cu_{n-1})d\tau$$

$$\omega_n=\varphi_1^1(\tau)+\int_{\tau_0}^{\tau}(F(\xi,\ \tau)-av_{n-1}-b\omega_{n-1}-cu_{n-1})d\xi$$

$$U_n=\varphi_2(\xi)+\int_{\tau}^{\tau}\omega_{n-1}\,dr \qquad n=1,2,3,,,,, \qquad (1.7)$$

(U_n), $\{V_n\}$, $\{\omega_n\}$ ketma-ketlklarning yaqinlashuvchanligini isbotlaymiz.

Bu uchun $\varphi_1(\tau),\ \varphi_2(\xi)$ $\varphi_1(\tau),\ \varphi_2(\xi)$ (*F, a, b, c*) funksiyalar (2) to'g'ri to'rtburchakda chegaralangan b'lsin.

1.7) dan quydagi sistemaga kelamiz .

$$v_{n+1}-v_n=\int_{\tau}^{\tau}[a(\xi,\tau)(v_n-v_{n-1})+b(\xi,\tau)(\omega_n-\omega_{n-1})+c(\xi,\tau)(u_n-u_{n-1})]d\tau$$

$$\omega_{n+1}-\omega_n=\int_{\xi}^{\xi}[a(\xi,\tau)(v_n-v_{n-1})+b(\xi,\tau)(\omega_n-\omega_{n-1})+c(\xi,\tau)(u_n-u_{n-1})]d\xi$$

$$U_{n-1}-u_n=\int_{\tau}^{\tau}(\omega_n-\omega_{n-1})dr \qquad \mathbf{(1.8)}$$

Endi $|U_{n-1}-u_n|$, $|v_n-v_{n-1}|$, $|\omega_n-\omega_{n-1}|$ lar uchun quydagi tengsizliklar o'rinli ekanligini isbotlaymiz .

$$|v_n-v_{n-1}| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!},$$

$$|\omega_n-\omega_{n-1}| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!},$$

$$|U_{n-1}-u_n| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!}, \qquad (1.9)$$

Bu yerda $k>|a(\xi,\tau)+|b(\xi,\tau)|+|c(\xi,\tau)|$ va A n-ga bog'liq bo'lmagan chegaralangan son .

Agar A katta chegaralangan son ekanligini olsak $n=1$ bo'lganda (1.9) baholashlar o'rinli ekanligiga ishonch hosil qilish qiyin emas (1.9) baholashlarni n- uchun o'rinli deb ularning $(n+1)$ uchun o'rinli ekanligini isbotlaymz. (1.8) sistemada

$$| \quad v_n-v_{n-1} \quad | \quad \int_{\tau_0}^{\tau}(|a|+|b|+|c|) \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!}$$

$$A\bullet K^n\frac{(\xi+\tau-\xi_0-\tau_0)}{(n-1)!}d\tau = A\bullet K^n\left[\frac{(\xi+\tau-\xi_0-\tau_0)}{n!}-\frac{(\xi-\xi_0)^n}{n!}\right] \quad A\bullet K^n\frac{(\xi+\tau-\xi_0-\tau_0)^n}{n!}$$

(1.9) tengsizliklarning qolganlari ham shunga o'xshash isbotlanadi.

Shundan keyin.

$$U_0+\sum_{n=1}(U_n-u_{n-1}),\quad v_0+\sum_{n=1}(v_n-v_{n-1}),\qquad \omega_0+\sum_{n=1}\omega_n-\omega_{n-1}$$

$$A+A\sum_{n=1}K^{n-1}\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!} \qquad (1.10)$$

Qatorlarni qaraymiz.

(1.11) qator tekis yaqinlashadi va uning yig'indisi $A+Ae\ K(\xi+\tau-\xi_0-\tau_0)$ funksiyaga teng.

U holda (9) baholashga asosan (1.10) qatorlar ham teng yaqinlashadi. Bundan (U_n), $\{V_n\}$, $\{\omega_n\}$ ketma-ketliklarnong $\{x_0<x<a,\ y_0<y<b\}$ to'g'ri to'rtburchakda tekis yaqinlashuvchanligi kelib chiqadi ularning limitik funksiyasini u, v, ω desak va (1.7) ga asosan ular (1.6) sistemani qanoatlantiradi. Demak biz yuqorida quygan (1.1), (1.2) xaraktristik masalamizning yechimi mavjud ekan.

Grusa masalasining yagonaligi.

(1), (2). Xaraktristik masalaning yechimi yagonaligini ham isbotlash qiyin emas.

Haqiqatdan ham $F=0$, $\varphi_1(\tau)=\varphi_2(\xi)=0$ desak (6) sistema $v=0$, $v=0$, $\omega=0$ yechimlarga ega bo'lishini qandaydir $|u|<A$, $|v|<A$, $|\omega|<A$ shartlarni bajaruvchi u, v, ω yechimlar quydagi

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$$|u| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!},$$

$$|v| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!},$$

$$|\omega| \quad K^{n-1}A\frac{(\xi+\tau-\xi_0-\tau_0)^{n-1}}{(n-1)!}, \qquad \textbf{(1.11)}$$

Tengsizliklarni qanoatlantiradi (1.11) tengsizlik (1.9) tengsizlikga o'xshash isbotlanadi (1.11) tengsizlik ixtiyoriy ekanligi kelib chiqadi.

1.3 Eyler-Darbu tenglamasi uchun Riman funksiyasi.

Aralash tipdagi tenglamalar uchun chegaraviy masalalarni o'rganishda quydagi Eyler-Darbu tenglamasini keng uchiraydi.

$$E(\alpha,\beta)=\frac{D^2u}{D\xi d\tau}-\frac{\beta}{\xi-\tau}\frac{Du}{D\xi}+\frac{\alpha}{\xi-\tau}\frac{Du}{D\tau}=0 \qquad (1.12)$$

Bu yerda α, *va* β o'zgarmas sonlar Agar quydagicha yangi v($\xi-\tau$) funksiyani quydagi $u(\xi-\tau)=(\xi-\tau)^{1-}\ \alpha-\beta\ v(\xi-\tau)$ (1.13)

Formula orqali kiritsak (1.12) tenglamani

$$E(\alpha,\beta)=\frac{D^2u}{D\xi d\tau}-\frac{1-\alpha}{\xi-\tau}\frac{Du1}{D\xi}+\frac{1-\beta}{\xi-\tau}\frac{Du}{D\tau}=0 \qquad (1.14)$$

Z(α,β) bilan E(α,β) = 0 tenglamaning ixtiyoriy yechimini belgilasak va (1.13) almashtirishdan foydalansak quydagi tenglikga ega bo'lamiz.

$$Z(\alpha,\beta)=(\xi-\tau)^{1-}\ \alpha-\beta \quad z(1-\beta,\ 1\text{-}\alpha) \qquad (1.15)$$

(12) tenglamaning xususiy yechimlarini topish uchun.

$$t=\frac{\xi}{\tau}, \quad u=x^k\varphi(t) \qquad (1.16)$$

almashtrish bajaramiz bu yerda k-parametr (1.16) (1.13) tengliklardan foydalanib quydagi tenglamaga kelamiz.

$$t(1\text{-}t)+[1-\lambda-\alpha-(1-\lambda+\beta)t]\varphi'(t)+k\beta\varphi(t)=0 \qquad (1.17)$$

(1.17) tenglama odatda Gauss tenglamasi deyiladi va uning t=0 nuqta atirofida chiziqli bog'liqmas ikkita $\varphi_1(t),\ \varphi_2(t)$ lar

$\varphi_1(t) = F(-k;\ \beta;\ 1-k-\alpha;\ t)$

$\varphi_2(t) = t^{k+\alpha} F(\alpha,\ \alpha+\beta+k,\quad 1+\alpha+k;\quad t)$ (1.18)

Bu yerda *F(a, b, c, t)* giperbolik qatr bo'lib u quydagicha yoziladi.

$$F(a,b,c,t) = \\ =1+ \frac{ab}{\tau\ c}t + \frac{a(a+1)b(b+1)}{2:c(c+1)}t^2 + \ldots\ldots\ldots + \frac{a(a+1)\ldots.(a+n-1)\ b(b+1)\ldots.(b+n-1)}{n:c(c+1)\ldots.(c+n-1)}t^n + \ldots.. \quad (1.19)$$

u holda (1.13) ga asosan (1.12) tenglama yechimlari quydagicha bo'ladi.

$$U_1(\xi-\tau) = \xi^{.k}\ \ F(-k;\ \beta;\ 1-k-\alpha;\ \frac{\tau}{\xi}),$$

$$U_2(\xi-\tau) = \xi^{.-\alpha}\tau^{\lambda+2}(\alpha,\ \alpha+\beta+k,\ 1+\alpha+\tau;\ \frac{\tau}{\xi}) \quad (1.20)$$

Yuqoridagilarga asosan Riman funksiyasi tushunchasiga asosan (1.12) tenglamaning R(ξ, τ; ξ_0, τ_0) –Riman funksiyasi quydagi qo'shma differensial tenglamani qanoatlantiradi.

$$\frac{D^2 R}{D\xi D\tau} - \frac{D}{D\xi}\left(-\frac{\alpha}{\xi-\psi}R\right) - \frac{D}{D\tau}\left(\frac{\beta}{\xi-\tau}R\right) = 0 \quad (1.21)$$

Giperbolik tipdagi buziladigan xususiy hosilali diferinsal tenglama uchun Koshe Gursaning ikkinchi masalasi.

2.1 Koshi Gursaning ikkinchi masalasining qo'yilishi.

Tekislikda gepirbolik tipdagi buziladigan birinchi tur tenglama berilgan bo'lsin.

$$Y^m U_{xx} + U_{yy} + a(x,y)U_x + b(x,y)U_y + c(x,y)U = f(x,y),\quad y>0 \quad (2.1)$$

Bu yerda *a, b, c f* –funksiyalar koefsentlari bo'lib differinsallanuvchi funksiyalar va *m>0* haqiqiy son (2.1) tenglama y=0 to'g'ri chiziqda (ox-o'qida) parabolic buziladi (2.1) tenglamaning xarakteristikalari.

$$x + \frac{2}{m+2}y^{\frac{m+2}{2}} = \text{const}$$

$$x - \frac{2}{m+2}y^{\frac{m+2}{2}} = \text{const} \quad (2.2)$$

egri chiziqlardan iborat (2.1) tenglamaning parobalik buzilish chizig'i *y=0* to'g'ri chiziq (2.1) tenglamaning xaraktristikasi bo'lmaydi bu holda adabiyotlar tenglamaning geperbolik tipdagi buziladigan birinchi tur tenglama ham deyiladi.

Ma'lumki gepirbolik tipdagi buziladigan differinsal tenglamalar uchun umuman Koshi, Grussa Darbu masalalari korekit qo'yilmagan bo'lishi mumkin. (2.1) tenglamani *y=0* to'g'ri chiziqning A(0, 0) B(1, 0) kesmasiga tayanuvchi D xaraktristik uchburchakda qaraymiz demak D bilan $x-\frac{2}{m+2}y^{\frac{m+2}{2}}=0$, $x+\frac{2}{m+2}y^{\frac{m+2}{2}}=1$ xaraktristikalar va $y=0$ to'g'ri chiziq bilan chegaralangan sohani D bilan belgilaymiz . agar buzilish kursatgichi m soni 0< m <1 shartni qanoatlantirsa tenglama uchun Koshi. Gursa Darbu masalalari korrekt qo'yilgan.

m=1 bo'lgan holni qaraymiz

u holda (1) tenglama quydagi kurinishga utadi.

$Yu_{xx}+u_{yy}+au_x+bu_y+cu=1$ $\quad y>0$ (2.3)

Haraktristikalar esa

$x+\frac{2}{3}y^{\frac{2}{3}}=const$ $\quad x-\frac{2}{3}y^{\frac{2}{3}}=const$ (2.4)

ko'rinishga ega D xaraktristik uchburchak qo'ydagi chizmadagi ko'rinishni oladi.

Koshi Gursaning ikkinchi masalasi :

(3) tenglamaning D sohada regulyar D uzluksiz va

$U/_{AC}=\varphi(x)$ $\quad 0<x \frac{1}{2}$ (2.5)

$U_y/_{AB}=\psi(x)$ $\quad 0<x<1$ (2.6)

Shartlarni qanoatlantruvchi yechmi topilsin.

Bu yerda $\varphi(x)$ $\psi(x)$ berilgan funksiyalar bo'lib o'zlarining mos ravushda uchunchi va to'rtinchi tartibli hosilalari bilan uzluksiz.

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