МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА
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Maksimal printsip va xatolar tahlili

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Kirish.

Ushbu maqolaning maqsadi chegaraviy masalalarning oddiy va qisman differensial tenglamalarini yechish uchun chekli ayirma va chekli element usullari bilan tanishtirib o`tamiz.

Asosiy e'tibor chekli farq va chekli elementlar metodlari va ularni oqilona matematik nazariya bilan amalga oshirishda muhim tafsilotlarni tushunishga qaratilgan. Biz ikki yoki undan yuqori o'lchamlarni ko'rib chiqishdan oldin bir o'lchovli muammolarni har tomonlama muhokama qilishdan boshlaymiz. Shuningdek, biz tegishli sohalarda ko'proq ma'lumot olishni istaganlar uchun ba'zi foydali ma'lumotnomalarni sanab o'tamiz. Dastlab, maksimal prinsip tushunchasini ko`rib o`tamiz.

$$L = a\frac{\partial^2}{\partial x^2} + 2h\frac{\partial^2}{\partial x \partial y} + c\frac{\partial^2}{\partial y^2},\ \mathrm{b}^2 - ac < 0,\ \ \text{for}\ (\mathrm{x}, \mathrm{y}) \in \Omega,$$

elliptik differentsial operatorini ko'rib chiqamiz va umumiylikni yo'qotmasdan $a > 0,\ c > 0$ deb faraz qilamiz. Maksimal printsip quyidagi teoremada berilgan.

1 teorema. *Agar* $u(x, y) \in C^3(\Omega)$ *chegaralangan* Ω *sohada* $Lu(x, y) \geq 0$ *ni qanoatlantirsa, u holda.* $u(x, y)$ *soha chegarasida maksimal qiymatga ega bo'ladi.*

Isbot: Agar teorema to'g'ri bo'lmasa, u holda $(x_0, y_0) \in \Omega$ lokal nuqtasi mavjud bo'lib, $u(x_0, y_0) \geq u(x, y)$ barcha $(x, y) \in \Omega$ uchun, lokal ekstremum (x_0, y_0) uchun zarur shart – bu:

$$\frac{\partial u}{\partial x}(x_0, y_0) = 0,\ \frac{\partial u}{\partial x}(x_0, y_0) = 0$$

Endi (x_0, y_0) soha chegarasida bo'lmagani va *u(x, y)* uzluksiz bo'lganligi sababli, **Q** sohaida (x_0, y_0) ning qo'shnisi mavjud bo'lib, u yerda biz Teylor kengaytmasiga ega bo’lamiz, () ning yuqori belgisi bilan

$$u(x_0+\Delta x, y_0+\Delta y)=u(x_0,y_0)+\frac{1}{2}\left((\Delta x)^2 u_{xx}^0+2\Delta x\Delta y\cdot u_{xx}^0+(\Delta y)^2 u_{yy}^0\right)$$
$$+O\left((\Delta x)^3,(\Delta y)^3\right),$$

funksiyalar baholanganligini bildiradi. (x_0,y_0)da, ya'ni $u_{xx}^0=\frac{\partial^2 u}{\partial x^2}(x_0,y_0)$ ifoda (x_0,y_0) da baholanadi va hokazo.

$u(x_0+\Delta x, y_0+\Delta y)\le u(x_0,y_0)$ barcha yetarlicha kichik Δx va Δy, uchun

$$\frac{1}{2}\left((\Delta x)^2 u_{xx}^0+2\Delta x\Delta y\cdot u_{xx}^0+(\Delta y)^2 u_{yy}^0\right)\le 0 \qquad (1)$$

Boshqa tomondan, berilgan shartdan

$$Lu^0=a^0u_{xx}^0+2b^0\cdot u_{xx}^0+c^0u_{yy}^0\ge 0, \qquad (2)$$

Bu yerda $a^0=a(x_0,y_0)$va boshqalar, Teylor kengayishiga qarama – qarshilikni olishi uchun yuqoridagi tengsizlikni quyidagicha qayta yozamiz.

$$\left(\sqrt{\frac{a^0}{M}}\right)u_{xx}^0+2\sqrt{\frac{a^0}{M}}\frac{b^0}{\sqrt{a^0M}}u_{xy}^0+\left(\frac{b^0}{\sqrt{a^0M}}\right)^2u_{yy}^0$$
$$+\frac{u_{yy}^0}{M}\left(c^0-\frac{(b^0)^2}{a_0}\right)\ge 0, \qquad (3)$$

Bu yerda $M>0$ doimiy hisoblanadi. M ning vaziasi etarlicha kichik bo'lgan Δx va Δy ni tanlashdir.

Endi quyidagi ifodani ko`rsak,

$$\Delta x=\sqrt{\frac{a^0}{M}},\quad \Delta y=\frac{b^0}{\sqrt{a^0M}} \qquad (4)$$

(1) ifodadan quyidagini bilamiz.

$$\frac{a^0}{M}u_{xx}^0+\frac{2b^0}{M}u_{xy}^0+\frac{b^0}{a^0M}u_{yy}^0\le 0. \qquad (5)$$

Natijada quyidagi kelib chiqadi.

$$\Delta x = 0, \qquad \Delta y = \sqrt{\left(c^0 - \frac{(b^0)^2}{a^0}\right) / M}; \tag{6}$$

va yana (1) dan,

$$(\Delta y)^2 u^0_{yy} = \frac{1}{M}\left(c^0 - \frac{(b^0)^2}{a^0}\right) u^0_{yy} \le 0 \tag{7}$$

Shunday qilib, (4) va (5) dan (3) chap tomoni ijobiy bo'lmasligi kerak, bu

$$Lu^0 = a^0 u^0_{xx} + 2b^0 u^0_{xy} + c^0 u^0_{yy} \ge 0, \tag{8}$$

shartga zid keladi va bu bilan isbot to`ldiriladi.

Boshqa tomondan, agar *Lu < 0 bo'lsa, u ning* ***m*** minimal qiymati Ω chegarasida bo'ladi. Umumiy elliptik tenglamalar uchun maksimal printsip quyidagicha.

$$Lu = au_{xx} + 2bu_{xy} + cu_{yy} + d_1u_x + d_2u_y + eu = 0, \quad (x,y) \in \Omega,$$
$$b^2 - ac < 0, \quad a > 0,\ c > 0, \quad e \le 0, \tag{9}$$

bo'lsin, bu erda Ω chegaralangan soha hisoblanadi. U holda 1 teoremadan *u(x, y)* ifoda Ω ning lokal qismida musbat lokal maksimal yoki manfiy ***m*** lokal minimal bo'lishi mumkin emas.

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