Tenglamalar Sistemasini Gauss Usuli Yechish, Natijaviy Eguvchi Moment Epyurasini Qurish

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Anostatsiya: Kanonik tenglamalar sistemasi Gauss usuli bilan yechish - bu bizga yana bir usulni namoyish etadi hamda statik noaniq tizimlarni qulayroq usul bilan tekshirish imkonini ham beradi.

Kalit so‘zlar: Gauss usuli, kanonik tenglamalar, natijalar, koeffitsientlar, ozod hadlar, Tayanch reaksiyalar, tenglamalar, guvchi moment epyurasi.

Chiziqli algebradagi matritsa elementlarning to'rtburchaklar qatorini anglatadi (jadval). Quyida qavs ichiga kiritilgan buyumlar to'plami mavjud. Bu matritsalar. Yuqoridagi misoldan ko'rishingiz mumkinki, to'rtburchaklar qatorlardagi elementlar nafaqat sonlardir. Matritsa matematik funktsiyalar, algebraik belgilardan iborat bo'lishi mumkin.

Ba'zi tushunchalarni tushunish uchun a elementlardan A matritsasini tuzamiz$_{ij}$... Ko'rsatkichlar faqat harflar emas: i - jadvaldagi satr raqami, j - a element joylashgan chorrahadagi ustun soni$_{ij}$... Shunday qilib, biz a kabi elementlarning matritsasini olganimizni ko'ramiz$_{11}$, a_{21}, a_{12}, a_{22} va hokazo. n harfi ustunlar sonini, m harfi qatorlar sonini bildiradi. M × n belgisi matritsaning o'lchamini bildiradi. Bu to'rtburchaklar elementlar qatoridagi qatorlar va ustunlar sonini belgilaydigan tushuncha. Matritsada bir nechta ustun va satr bo'lishi shart emas. 1 × n o'lchovlar uchun elementlar massivi bitta qatorga, m × 1 uchun esa bitta ustunga ega. Agar qatorlar soni va ustunlar soni teng bo'lsa, matritsa kvadrat deyiladi.Har bir kvadrat matritsada determinant (det A) mavjud. Ushbu atama A matritsasi bilan bog'liq bo'lgan raqam sifatida tushuniladi.

Matritsalarni muvaffaqiyatli echish uchun yana bir nechta muhim tushunchalar asosiy va yon diagonallardir. Matritsaning asosiy diagonali - yuqori chap burchakdan stolning o'ng burchagiga tushadigan diagonal. Yon diagonali pastki chap burchakdan o'ng burchakka ko'tariladi.

Quyidagi rasmga qarang. Unda siz matritsa va diagrammani ko'rasiz. Avval matritsa bilan shug'ullanamiz. Lineer algebrada bunday turdagi matritsa qadam matritsasi deb nomlanadi. Uning bitta xususiyati bor: agar a_{ij} i-qatordagi birinchi nolinchi element, so'ngra matritsadan quyidagi va chapdagi barcha boshqa elementlar$_{ij}$, nolga teng (ya'ni, harf belgilariga berilishi mumkin bo'lgan barcha elementlar$_{kl}$, bu erda k> i va l<> Endi sxemani ko'rib chiqamiz. Bu matritsaning pog'onali shaklini aks ettiradi. Diagrammada 3 turdagi hujayralar ko'rsatilgan. Har bir tur ma'lum elementlarni bildiradi: bo'sh kataklar - matritsaning nol elementlari;

soyali kataklar - nolga teng yoki nolga teng bo'lmagan o'zboshimchalik elementlari;

qora kvadratchalar - nolga teng bo'lmagan elementlar, ular burchak elementlari, "qadamlar" deb nomlanadi (matritsada bunday elementlar yonida -1, 5, 3, 8 raqamlari ko'rsatilgan).

Matritsalarni echishda ba'zan qadamning "uzunligi" 1dan katta bo'lganida natija olinadi. Bunga yo'l qo'yiladi. Faqat qadamlarning "balandligi" muhim ahamiyatga ega. Bosqichli matritsada ushbu parametr har doim biriga teng bo'lishi kerak.

Matritsani pog'onali shaklga kamaytirish

Har qanday to'rtburchaklar matritsani pog'onali shaklga o'tkazish mumkin. Bu oddiy transformatsiyalar tufayli amalga oshiriladi. Ular quyidagilarni o'z ichiga oladi:

joylarda chiziqlarni qayta tashkil etish;

agar kerak bo'lsa, boshqa qatorning bir qatoriga qo'shib, biron bir raqamga ko'paytiring (siz ayirboshlash operatsiyasini ham bajarishingiz mumkin).

Muayyan muammoni hal qilishda elementar o'zgarishlarni ko'rib chiqing. Quyidagi rasmda A matritsasi ko'rsatilgan bo'lib, uni pog'onali shaklga o'tkazish kerak.

Muammoni hal qilish uchun biz algoritmga amal qilamiz:

Chap tarafdagi yuqori burchakdagi birinchi element (ya'ni "etakchi" element) 1 yoki –1 ga teng bo'lgan matritsada transformatsiyalarni bajarish qulay. Bizning holatimizda yuqori qatorning birinchi elementi 2 ga teng, shuning uchun birinchi va ikkinchi qatorlarni almashtiramiz.

2, 3 va 4-qatorlar bo'yicha ayirish amallarini bajaramiz. "Etakchi" element ostida birinchi ustunda nollarni olishimiz kerak. Ushbu natijaga erishish uchun: 2-qator elementlaridan biz ketma-ket 2-songa ko'paytirilib, 1-qatorning elementlarini chiqaramiz; 3-qator elementlaridan biz ketma-ket 1-qator elementlarini ayirboshlaymiz, 4 ga ko'paytiramiz; satr No4 elementlaridan ketma-ket No1 satr elementlarini ayirib tashlaymiz.

Keyinchalik, biz kesilgan matritsa bilan ishlaymiz (1-ustunsiz va 1-qatorsiz). Ikkinchi ustun va ikkinchi qator kesishgan joyda yangi "burilish" elementi –1 ga teng. Qatorlarni o'zgartirishga hojat yo'q, shuning uchun biz birinchi ustunni va birinchi va ikkinchi qatorlarni o'zgarishsiz qayta yozamiz. "Etakchi" element ostida ikkinchi ustunda nollarni olish uchun ayirish amallarini bajaraylik: uchinchi qator elementlaridan biz ketma-ket ikkinchi qator elementlarini 3 ga ko'paytiramiz; to'rtinchi qator elementlaridan biz ketma-ket ikkinchi qator elementlarini ayiramiz, 2 ga ko'paytiramiz.

Oxirgi qatorni o'zgartirish kerak. Uchinchi qator elementlarini ketma-ketlikdagi elementlaridan chiqarib tashlang. Shunday qilib, biz pog'onali matritsani oldik.

Matritsalarni bosqichma-bosqich qisqartirish chiziqli tenglamalar (SLE) tizimlarini Gauss usuli bilan echishda qo'llaniladi. Ushbu usulni ko'rib chiqishdan oldin, SLN bilan bog'liq atamalarni tushunaylik.

Matritsalar va chiziqli tenglamalar tizimlari

Matritsalar turli fanlarda qo'llaniladi.Raqamlar jadvalidan foydalanib, masalan, Gauss usuli yordamida tizimga birlashtirilgan chiziqli tenglamalarni echishingiz mumkin. Dastlab, bir nechta atama va ularning ta'riflari bilan tanishib chiqamiz, shuningdek, bir nechta chiziqli tenglamalarni birlashtirgan tizimdan qanday qilib matritsa hosil bo'lishini ko'rib chiqamiz.

SLU – birinchi darajadagi noma'lumlar mavjud bo'lgan va noma'lumlarning hosilasi bo'lgan atamalar mavjud bo'lmagan bir nechta algebraik tenglamalar.

SLN yechimi - noma'lumlarning topilgan qiymatlari, ularni almashtirganda tizimdagi tenglamalar identifikatsiyaga aylanadi.

Qo'shma SLN - bu kamida bitta echimga ega bo'lgan tenglamalar tizimi.

Mos kelmaydigan SLN - bu echimlari bo'lmagan tenglamalar tizimi.

Matritsa chiziqli tenglamalarni birlashtirgan tizim asosida qanday tuziladi? Tizimning asosiy va kengaytirilgan matritsalari kabi tushunchalar mavjud. Tizimning asosiy matritsasini olish uchun jadvalga noma'lum narsalar uchun barcha koeffitsientlarni kiritish kerak. Kengaytirilgan matritsa erkin a'zolar ustunini asosiy matritsaga qo'shish yo'li bilan olinadi (u tizimga har bir tenglama tenglashtirilgan ma'lum elementlarni o'z ichiga oladi). Siz ushbu rasmni quyidagi rasmni o'rganib tushunishingiz mumkin.

birinchi narsa - bu chiziqli tenglamalarni o'z ichiga olgan tizim. Uning elementlari: a_{ij} - raqamli koeffitsientlar, x_i - noma'lum miqdorlar, b_{men} - bepul atamalar (bu erda i = 1, 2, ..., m va j = 1, 2, ..., n). Rasmdagi ikkinchi element bu koeffitsientlarning asosiy matritsasi. Har bir tenglamadan koeffitsientlar qatorga yoziladi. Natijada, matritsada tizimda qancha tenglamalar bo'lsa, shuncha qator mavjud. Ustunlar soni har qanday tenglamadagi eng katta koeffitsientlar soniga teng. Rasmdagi uchinchi element - erkin a'zolar ustuniga ega kengaytirilgan matritsa.

Gauss usuli haqida umumiy ma'lumot

Lineer algebrada Gauss usuli SLEni echishning klassik usuli hisoblanadi. U 18-19 asrlarda yashagan Karl Fridrix Gauss nomi bilan atalgan. U barcha zamonlarning eng buyuk matematiklaridan biridir. Gauss usulining mohiyati chiziqli algebraik tenglamalar tizimi orqali elementar o'zgarishlarni amalga oshirishdan iborat. Transformatsiyalar yordamida SLN uchburchak (pog'onali) shaklning ekvivalent tizimiga tushiriladi, undan barcha o'zgaruvchilarni topish mumkin.

Shuni ta'kidlash kerakki, Karl Fridrix Gauss chiziqli tenglamalar tizimini echishning klassik usulini kashf etuvchi emas. Usul ancha oldin ixtiro qilingan. Uning birinchi tavsifi qadimgi xitoy matematiklarining bilimlari ensiklopediyasida "Matematik 9 ta kitobda" deb nomlangan.

Kanonik tenglamalar sistemasi Gauss usuli bilan yechilsin va natijalar tekshirib ko’rilsin.

Gauss jadvali

№	X_1	X_2	X_3	Δ_{ip}	S_i
1	δ_{11}	δ_{12}	δ_{13}	Δ_{1p}	S_1
2	δ_{21}	δ_{22}	δ_{23}	Δ_{2p}	S_2
3	δ_{31}	δ_{32}	δ_{33}	Δ_{3p}	S_3
1	δ_{11}	δ_{12}	δ_{13}	Δ_{1p}	S_1
2	$\alpha_{12} = \frac{\delta_{21}}{\delta_{11}}$	δ'_{22}	δ'_{23}	Δ'_{2p}	S'_2
3	$\alpha_{13} = \frac{\delta_{31}}{\delta_{11}}$	$\alpha_{23} = \frac{\delta'_{23}}{\delta'_{22}}$	δ''_{33}	Δ''_{3p}	S''_3

Birlik koeffitsiyentlar va ozod hadlarning aniqlangan qiymatlarini kanonik tenglamalarga qo’yib, quyidagi tenglamalar sistemasiga ega bo’lamiz:

$$\begin{cases} 405X_1 - 126X_2 + 18X_3 - 117 = 0; \\ -126X_1 + 324X_2 + 31X_3 + 14 = 0; \\ 18X_1 + 31X_2 + 11X_3 + 3 = 0. \end{cases}$$

Gauss jadvalini tuzamiz:

№	X_1	X_2	X_3	Δ_{ip}	S_i
	405	-126	18	-117	180
	-126	324	31	14	243
	18	31	11	3	63
1	δ_{11}	δ_{12}	Δ_{13}	Δ_{1p}	S_1
2	$\alpha_{12}=\frac{-126}{405}$	$\frac{6408}{22,5}$	$\frac{823,5}{22,5}$	$-\frac{504}{22,5}$	$\frac{6727,5}{22,5}$
3	$\alpha_{13}=\frac{18}{405}$	$\alpha_{23}=\frac{823,5}{6408}$	$\frac{489,1875}{89}$	$\frac{986}{89}$	$\frac{1475,1875}{89}$

$$\delta_{22}^{'}=\delta_{22}-\alpha_{12}\cdot\delta_{12}=324-\left(-\frac{126}{405}\right)\cdot(-126)=324-\frac{21}{67,5}126=\frac{324\cdot 67,5-21\cdot 126}{67,5}=$$

$$=\frac{19224}{67,5}=\frac{6408}{22,5}.$$

$$\delta_{23}^{'}=\delta_{23}-\alpha_{12}\cdot\delta_{13}=31-\left(-\frac{126}{405}\right)\cdot 18=31+\frac{7}{22,5}\cdot 18=\frac{31\cdot 22,5+7\cdot 18}{22,5}=\frac{823,5}{22,5}.$$

$$\Delta_{2p}^{'}=\Delta_{2p}-\alpha_{12}\cdot\Delta_{1p}=14-\left(-\frac{126}{405}\right)\cdot(-117)=14+\frac{7}{22,5}\cdot 117=\frac{14\cdot 22,5-7\cdot 117}{22,5}=-\frac{504}{22,5}.$$

$$S_2^{'}=S_2-\alpha_{12}\cdot S_1=243-\left(-\frac{126}{405}\right)\cdot 180=243+\frac{7}{22,5}\cdot 180=\frac{243\cdot 22,5+7\cdot 180}{22,5}=\frac{6727,5}{22,5}.$$

Tekshirish: 6408+823,5-504=6727,5.

$$\delta_{33}^{''}=\delta_{33}-\alpha_{13}\cdot\delta_{13}-\alpha_{23}\cdot\delta_{23}^{'}=11-\frac{18}{405}\cdot 18-\frac{823,5}{6408}\cdot\frac{823,5}{22,5}=11-0,8-\frac{45,75}{356}\cdot 36,6=$$

$$=\frac{10,2\cdot 356-45,75\cdot 36,6\cdot}{356}=-\frac{1956,75}{356}=\frac{489,1875}{89}.$$

$$\Delta_{3p}^{''}=\Delta_{3p}-\alpha_{13}\cdot\Delta_{1p}-\alpha_{23}\cdot\Delta_{2p}^{'}=3-\frac{1}{22,5}\cdot(-117)-\frac{823,5}{6408}\cdot\left(-\frac{504}{22,5}\right)=$$

$$=3+5,2+\frac{11,4375\cdot 22,4}{89}==\frac{8,2\cdot 89+11,4375\cdot\cdot 22,4}{89}=\frac{986}{89}.$$

$$S_3^{''}=S_3-\alpha_{13}\cdot S_1-\alpha_{23}\cdot S_2^{'}=63-\frac{18}{405}\cdot 180-\frac{823,5}{6408}\cdot\frac{6727,5}{22,5}=63-8-\frac{22,875}{178}\cdot 299=$$

$$=55-\frac{6839,625}{178}=\frac{55\cdot 178-6839,625}{178}=\frac{2950,375}{178}=\frac{1475,1875}{89}.$$

Tekshirish: 489,1875+986=1475,1875.

$$\delta_{33}^{''} \cdot X_3 + \Delta_{3p}^{''} = 0; \quad X_3 = -\frac{\Delta_{3p}^{''}}{\delta_{33}^{''}} = -\frac{986}{489{,}1875} = -2{,}0156\kappa Nm;$$

$$\delta_{22}^{'} \cdot X_2 + \delta_{23}^{'} \cdot X_3 + \Delta_{2p}^{'} = 0;$$

$$X_2 = -\frac{\delta_{23}^{'} \cdot X_3 + \Delta_{2p}^{'}}{\delta_{22}^{'}} = -\frac{823{,}5 \cdot (-2{,}0156) + (-504)}{6408} = \frac{2163{,}8466}{6408} = 0{,}3377\kappa N;$$

$$\delta_{11} \cdot \mathrm{X}_1 + \delta_{12} \cdot X_2 + \delta_{13} \cdot X_3 + \Delta_{1p} = 0;$$

$$X_1 = -\frac{\delta_{12} \cdot X_2 + \delta_{13} \cdot X_3 + \Delta_{1p}}{\delta_{11}} = -\frac{(-126) \cdot 0{,}3377 + 18 \cdot (-2{,}0156) - 117}{405} = 0{,}4835\kappa N.$$

Noma'lumlarning qiymatlarini tekshirib ko'ramiz:

$405 \cdot 0{,}4835 - 126 \cdot 0{,}3377 + 18 \cdot (-2{,}0156) - 117 = 0; \quad -0{,}0135 \approx 0;$

$-126 \cdot 0{,}4835 + 324 \cdot 0{,}3377 + 31 \cdot (-2{,}0156) + 14 = 0; \quad 0{,}0102 \approx 0;$

$18 \cdot 0{,}4835 + 31 \cdot 0{,}3377 + 11 \cdot (-2{,}0156) + 3 = 0; \quad 0{,}0001 \approx 0.$

Noma'lumlarning qiymatlari aniqligi qoniqarli.

8. Natijaviy eguvchi moment epyurasi qurilsin.

8.1 Tayanch reaksiyalarni aniqlash.

$$\sum X = 0; \quad \mathrm{H_A} = q_1 \cdot 4 - P - X_2 = 2 \cdot 4 - 4 - 0{,}3377 = 3{,}6623\kappa N;$$

$$\sum M_B = 0;$$

$$\mathrm{X}_1 \cdot 9 - H_A \cdot 2 + q_1 \cdot 4 \cdot 4 - P \cdot 3 - q_2 \cdot 6 \cdot 3 - P \cdot 6 - X_3 - V_C \cdot 6 = 0;$$

$$V_C = \frac{1}{6}(X_1 \cdot 9 - H_A \cdot 2 + q_1 \cdot 4 \cdot 4 - P \cdot 3 - q_2 \cdot 6 \cdot 3 - P \cdot 6 - X_3) =$$

$$= \frac{1}{6}(0{,}4835 \cdot 9 - 3{,}6623 \cdot 2 + 2 \cdot 4 \cdot 4 - 4 \cdot 3 - 3 \cdot 6 \cdot 3 - 4 \cdot 6 - 2{,}0156) = \frac{45{,}0113}{6} = 7{,}5019\kappa N.$$

$$\sum \mathrm{M_C} = 0; \quad X_1 \cdot 15 + H_A \cdot 4 - q_1 \cdot 4 \cdot 2 - P \cdot 9 + X_2 \cdot 6 - X_3 - q_2 \cdot 6 \cdot 3 + V_B \cdot 6 = 0;$$

$$V_B = \frac{1}{6}(-X_1 \cdot 15 - H_A \cdot 4 + q_1 \cdot 4 \cdot 2 + P \cdot 9 - X_2 \cdot 6 + X_3 + q_2 \cdot 6 \cdot 3) =$$

$$= \frac{1}{6}(0{,}4835 \cdot 15 - 3{,}6623 \cdot 4 + 2 \cdot 4 \cdot 2 + 4 \cdot 9 - 0{,}3377 \cdot 6 + 2{,}0156 \cdot 6 + 2{,}0156 + 3 \cdot 6 \cdot 3) = 14{,}0144\kappa N.$$

Tekshiruvlar: 1. $\sum \mathrm{Y} = 0; \quad X_1 + V_B + V_C - P - q_2 \cdot 6 = 0;$

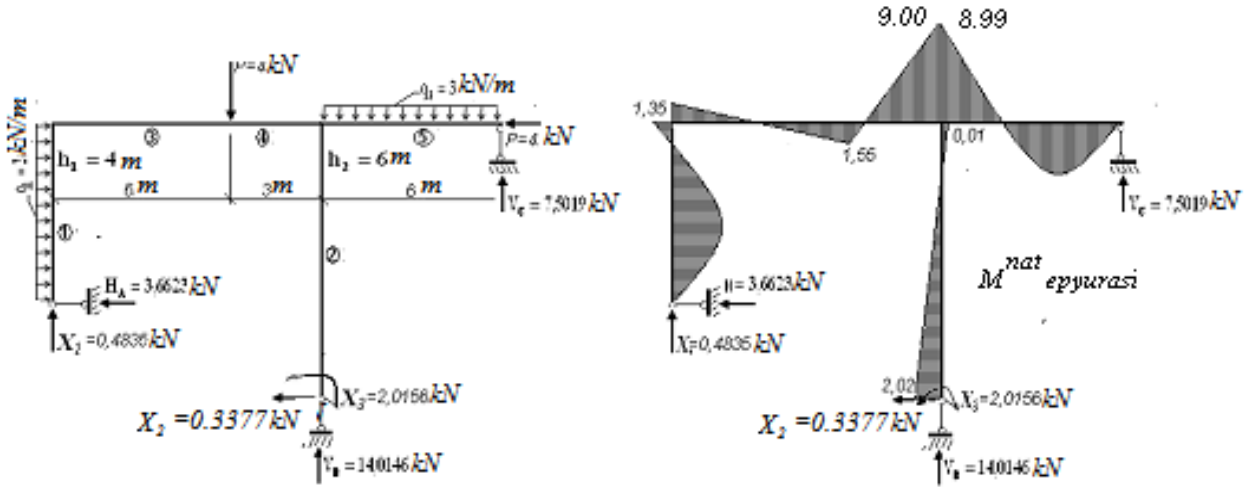
$0{,}4835 + 14{,}0144 + 7{,}5019 - 4 - 3 \cdot 6 = 0;$ 22-22=0; 0=0

2. $V_B = -2{,}5 \cdot 0{,}4835 - \frac{1}{3} \cdot 0{,}3377 + \frac{1}{6} \cdot 2{,}0156 + 15 = 14{,}0144 \kappa N;$

3. $V_C = 1{,}5 \cdot 0{,}4835 + \frac{1}{3} \cdot 0{,}3377 - \frac{1}{6} \cdot 2{,}0156 + 7 = 7{,}5019 \kappa N.$

Eguvchi moment epyurasini qurish.

Yuqoridagi tenglamalarga asosan natijaviy eguvchi moment epyurasining ordinatalari hisoblab chiqiladi va epyura quriladi (3.10-shakl). Mazkur uslubiy ko'rsatmaning hajmi chegaralangani sababli eguvchi moment epyurasining ordinatalarini hisoblashlar keltirilmagan.



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