



O'ZBEKISTON RESPUBLIKASI
OLIY VA O'RTA MAXSUS TA'LIM VAZIRLIGI
«TOSHKENT IRRIGATSIYA VA QISHLOQ XO'JALIGINI
MEXANIZATSIYALASH MUHANDISLARI INSTITUTI»
MILLIY TADQIQOT UNIVERSITETI



«NAZARIY VA QURILISH MEXANIKASI» KAFEDRASI

FAN: NAZARIY MEXANIKA

MA"RUZACHI:

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TOSHKENT-2022

4-ma'ruza.

PARALLEL KUCHLAR MARKAZI. QATTIQ JISMNING OG'IRLIK MARKAZI.

REJA:

- 1. Parallel kuchlar markazi.*
- 2. Qattiq jismning og'irlik markazi.*
- 3. Jismlarning og'irlik markazini aniqlash usullari.*



QATTIQ JISMNING OG'IRLIK MARKAZI.



1-rasm



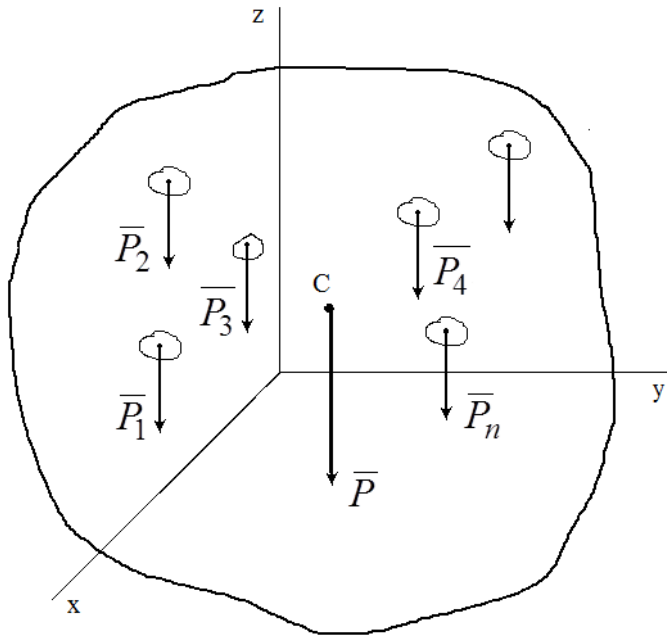
2-rasm



3-rasm

PARALLEL KUCHLAR MARKAZI

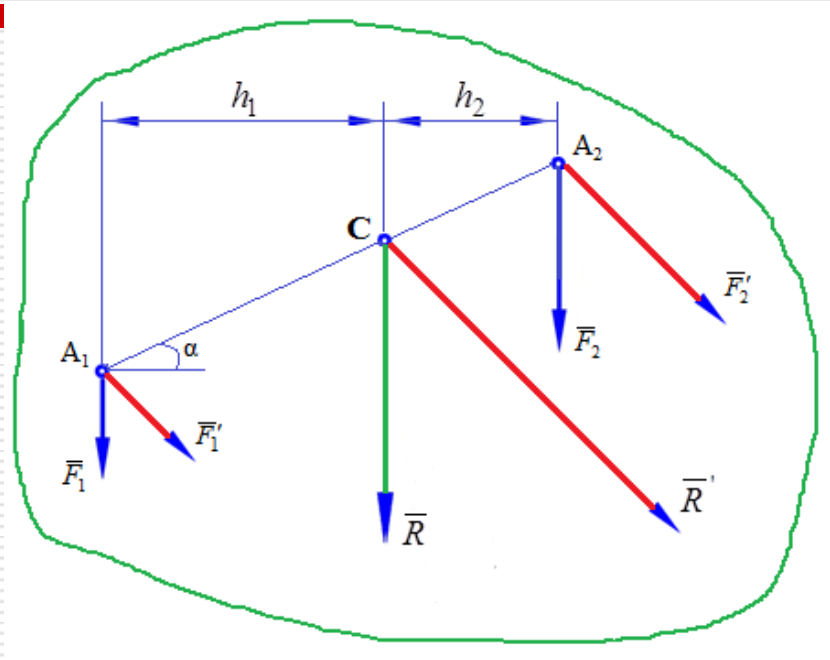
$$P = \sum P_k$$



4-rasm

$$m_C(\bar{R}) = m_C(\bar{F}_1) + m_C(\bar{F}_2)$$

$$0 = F_1 h_1 - F_2 h_2$$

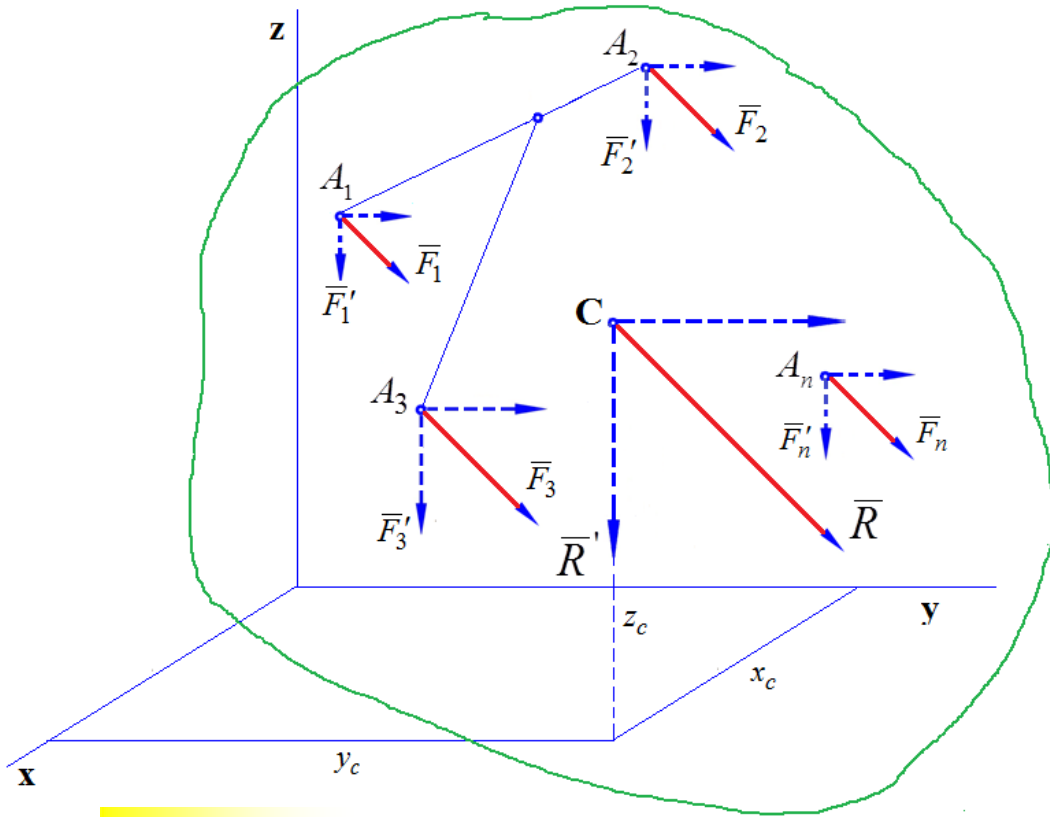


5-rasm

$$F_1 \cdot A_1 C = F_2 \cdot A_2 C$$

$$\frac{F_1}{F_2} = \frac{A_2 C}{A_1 C}$$

PARALLEL KUCHLAR MARKAZI



$$R = \sum F_K$$

$$m_y(\bar{R}') = \sum m_y(\bar{F}'_K)$$

$$m_y(\bar{F}'_1) = F'_1 \cdot x_1$$

$$m_y(\bar{F}'_2) = F'_2 \cdot x_2$$

$$m_y(\bar{R}') = R \cdot x_c$$

6-rasm

$$R \cdot x_c = F_1 x_1 + F_2 x_2 + \dots + F_n x_n = \sum F_K \cdot x_K$$

$$x_c = \frac{1}{R} \sum F_k \cdot x_k,$$

$$y_c = \frac{1}{R} \sum F_k \cdot y_k,$$

$$z_c = \frac{1}{R} \sum F_k z_k$$

PARALLEL KUCHLAR MARKAZI

Parallel kuchlarning markazini aniqlash uchun quyidagi ikkita qoidani bajarilishi shart:

- 1) Markazini aniqlanadigan parallel kuchlarni o'z ta'sir chiziqlari bo'yicha bir nuqtadan ikkinchi nuqtaga ko'chirish mumkin emas, ya'ni ularning qo'yilgan nuqtalari o'zgarmay qolishlari shart. Masalan og'irlik kuchlari shunday kuchlar guruhiga kiradilar.
- 2) Markazini aniqlanadigan parallel kuchlarning son qiymatlari o'zgarmas bo'lishi shart, aks holda markazning o'rni muhim bo'lmay qoladi.

Agar parallel kuchlarning modullari vaqt mobaynida o'zgaruvchan bo'lsa, ularning markazi bo'lgan C nuqtaning koordinatalri ham o'zgaruvchan funksiyadan iborat bo'ladi.

Agar ushbu shartlar bajarilsa, *har qanday parallel kuchlar sistemasi uchun shunday bir nuqta topish mumkinki, shu kuchlar sistemasini hohlagan tomonga burilganda ham u nuqta shu kuchlarning markazi bo'lib qolaveradi.*

Nazariy mexanika fanida bu nuqtani lotincha C harfi bilan belgilash qabul qilingan bo'lib, lotincha centrum - markaz degan ma'noni anglatadi.

Qattiq jismning og'irlik markazi

Yerning atrofida joylashgan har qanday zarrachaga ularning massalariga proporsional ravishda yerning tortish kuchi, boshqacha aytganda og'irlik kuchlari ta'sir etadi.

Umuman, zarrachalarning orasidagi masofa katta bo'lsa, ushbu og'irlik kuchlarining yo'nalishlari bir birlariga parallel bo'lmaydi. Lekin, zarrachalar orasidagi masofa yerning radiusiga nisbatan juda kichik masofani tashkil etgan hollarda, og'irlik kuchlarini o'zaro parallel deb qabul qilinadi. Og'irlik kuchining yo'nalishi va moduli o'zgarmas bo'lganligi uchun, har qanday qattiq jismning og'irlik markazi o'zgarmas bo'ladi. Quyida shu nuqtani aniqlash bilan shug'ullanamiz.

N - zarrachadan iborat qattiq jism berilgan bo'lsin va har bir zarrachaning og'irlik kuchi tegishlicha R_1, R_2, \dots, R_N ga teng bo'lib, koordinatalari $S_1(x_1, y_1, z_1), S_2(x_2, y_2, z_2), \dots, S_N(x_N, y_N, z_N)$ bo'lsin, u holda bu qattiq jismning umumiy og'irligi - $P = \sum P_k$ bo'ladi.

Bu kuchlar parallel bo'lgani uchun ularning markazi, ya'ni jismning og'irlik markazi yuqorida isbotlangan formulalar orqali aniqlanadi:

$$y_C = \frac{\sum y_k P_k}{P}$$

$$x_C = \frac{\sum x_k P_k}{P}$$

$$z_C = \frac{\sum z_k P_k}{P}$$

qattiq jismning og'irlik markazi, uning shunday bir nuqtasiki jismni qaysi tomonga aylantirishdan qat'iy nazar uning umumiy og'irligining ta'sir chizig'i shu nuqtani albatta kesib o'tadi.

Bir jinsli jismlarning og'irlik markazi koordinatalari

V hajmga ega bo'lgan jismning og'irlik markazi koordinatalarini aniqlash formulalari:

$$x_c = \frac{1}{V} \sum v_k \cdot x_k, \quad y_c = \frac{1}{V} \sum v_k \cdot y_k, \quad z_c = \frac{1}{V} \sum v_k \cdot z_k$$

Agar jism bir jinsli yupqa, yassi plastinkadan iborat bo'lsa, uning og'irlik markazi koordinatalarini aniqlash formulalari:

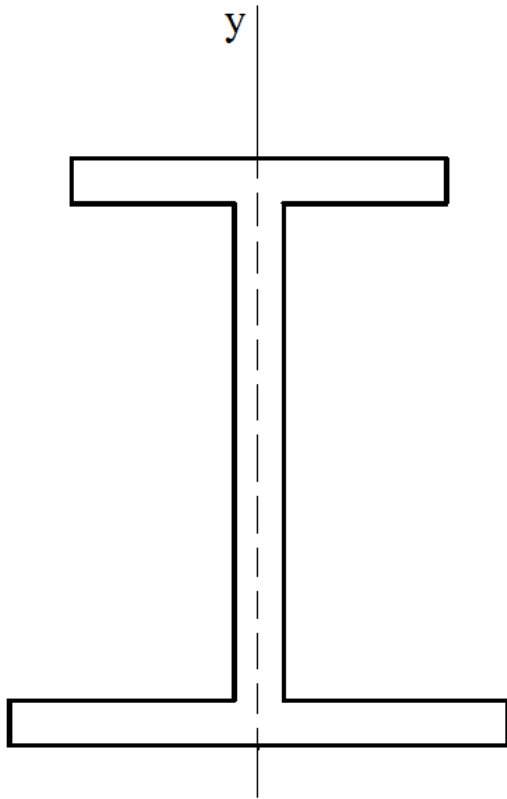
$$x_c = \frac{1}{S} \sum s_k \cdot x_k, \quad y_c = \frac{1}{S} \sum s_k \cdot y_k$$

Bir jinsli chiziq (ip, arqon, tros)ning og'irlik markazi koordinatalarini aniqlash formulalari:

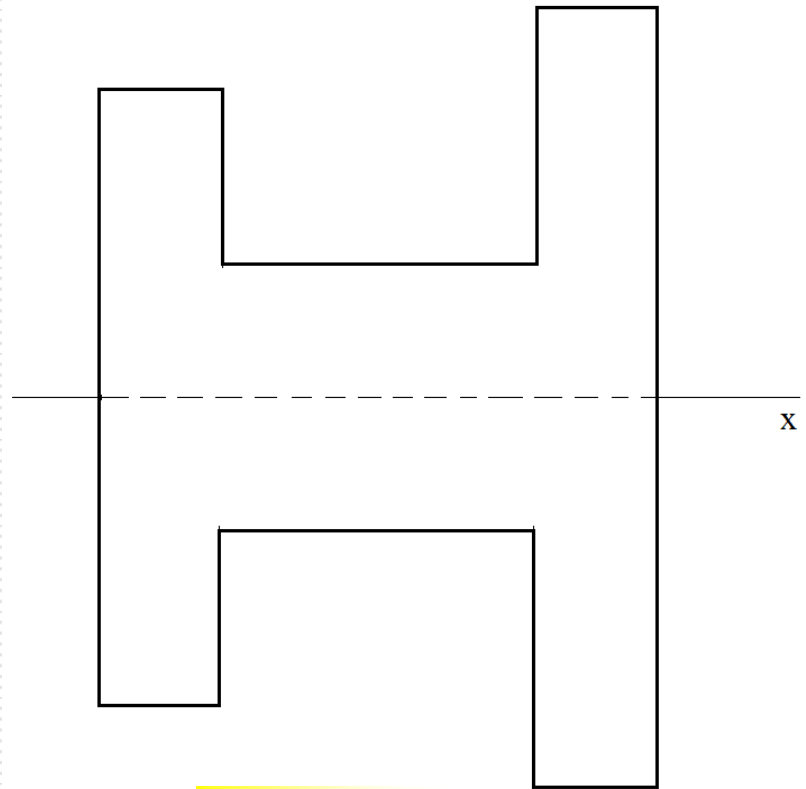
$$x_c = \frac{1}{L} \sum l_k \cdot x_k$$

Jismlarning og'irlik markazini aniqlash usullari

1. Simmetriya usuli.



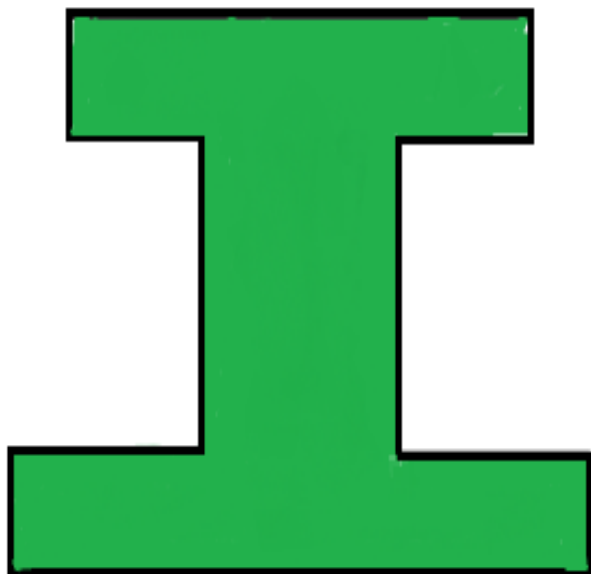
7-rasm



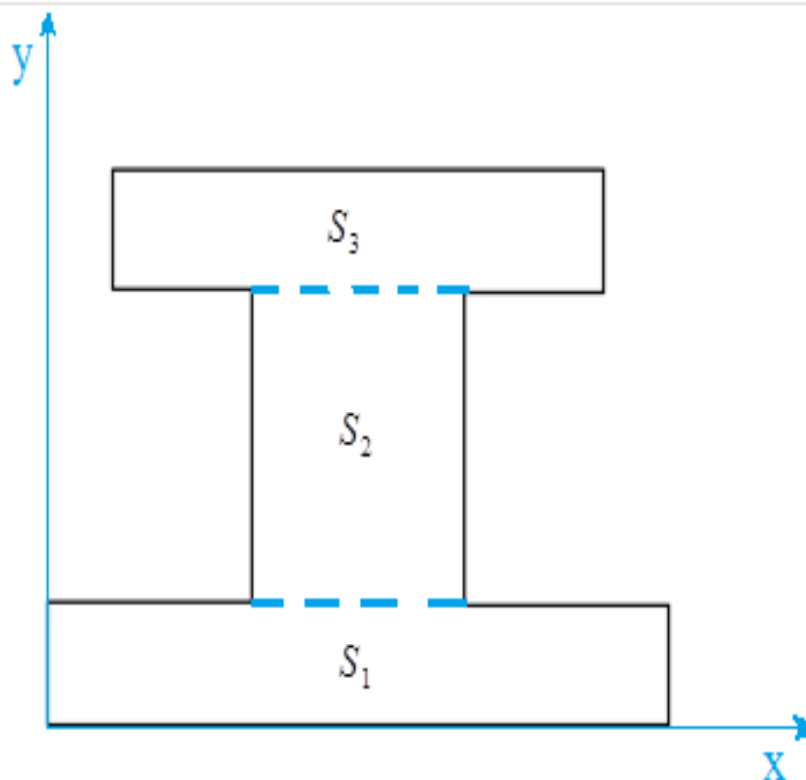
8-rasm

Jismlarning og'irlik markazini aniqlash usullari

2. Bo'laklarga ajratish usuli.



9-rasm

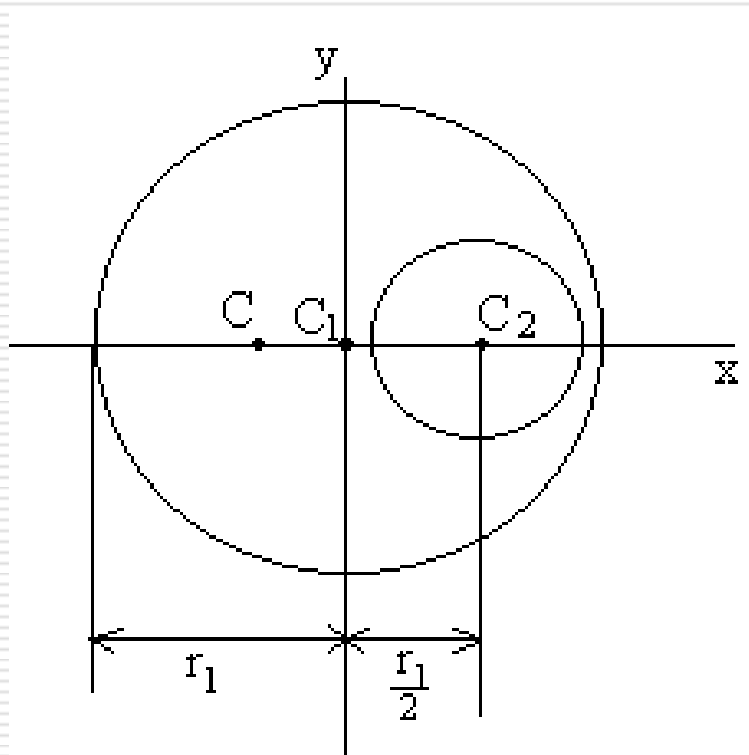


10-rasm

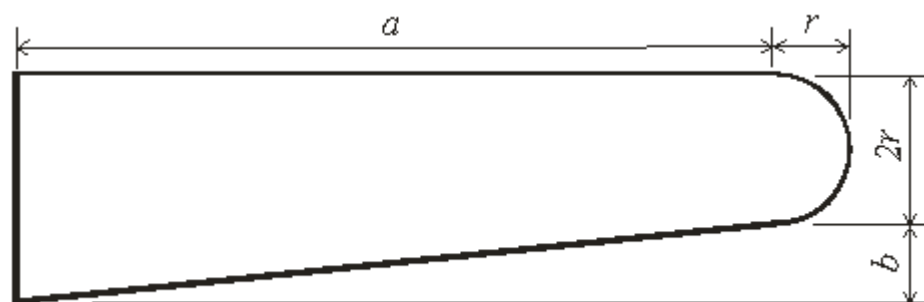
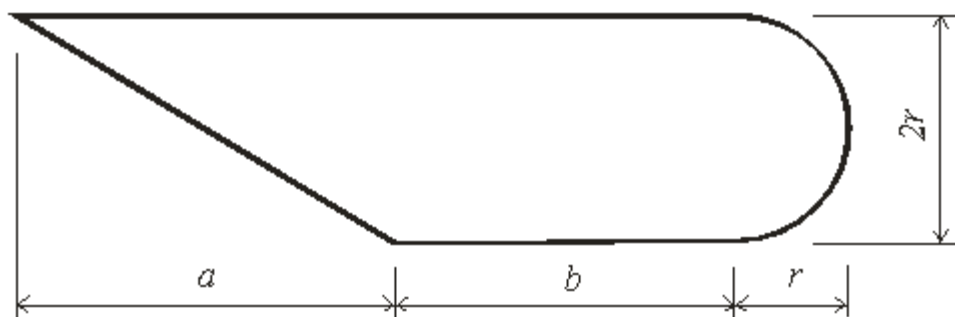
Jismlarning og'irlik markazini aniqlash usullari

3. Manfiy yuza usuli.

4. Integrallash usuli.



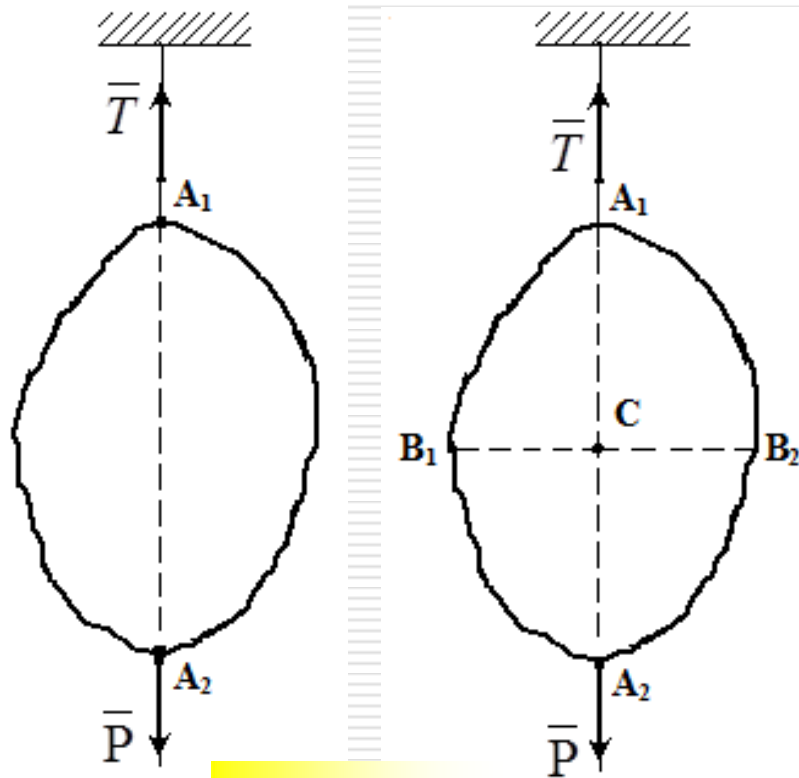
11-rasm



12-rasm

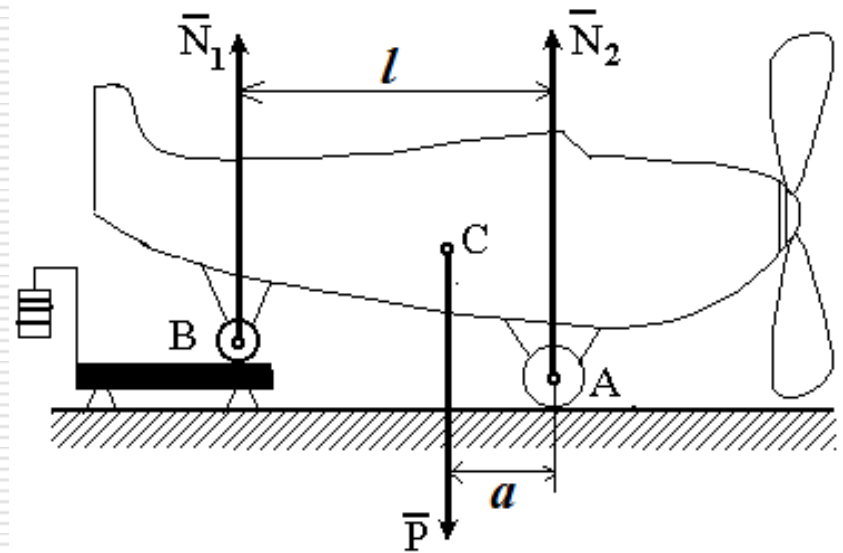
Tajriba usuli

1. Ipga osish usuli



13-rasm

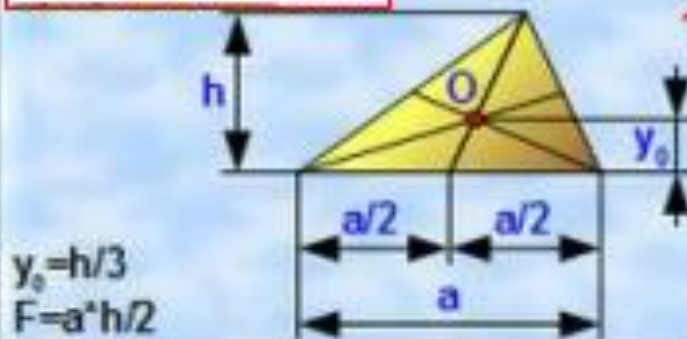
2. Taroziida tortish usuli



14-rasm

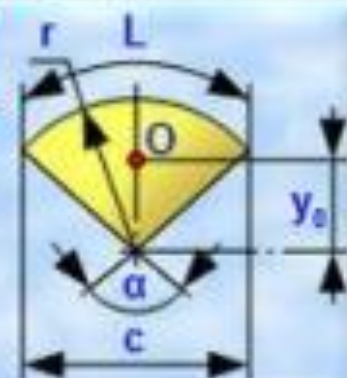
ba'zi bir jinsli jismlarning og'irlik markazlari

uchburchak uchun

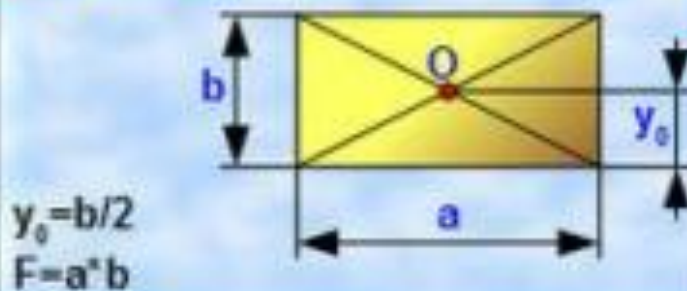


doira sektori uchun

$L = r \cdot \alpha$
 $c = 2 \cdot r \cdot \sin(\alpha/2)$
 $y_0 = 2 \cdot r \cdot c / (3 \cdot L)$
 $F = (r^2) \cdot \alpha / 2$

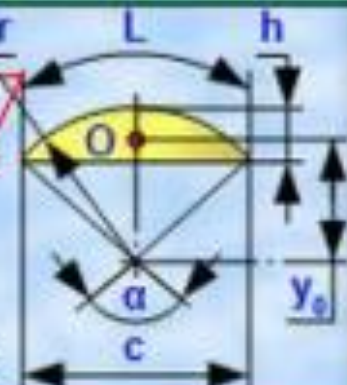


To'g'ri to'rtburchak uchun

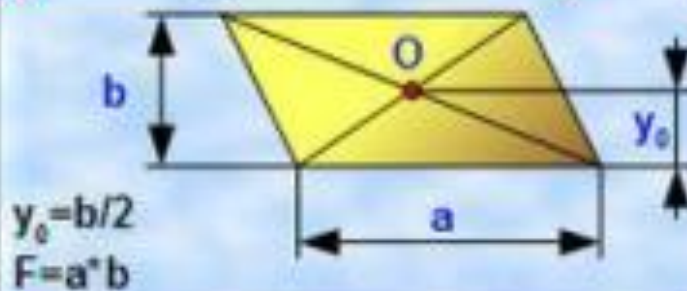


doira sigment uchun

$L = r \cdot \alpha$
 $c = 2 \cdot r \cdot \sin(\alpha/2)$
 $h = r - r \cdot \cos(\alpha/2)$
 $y_0 = (c^3) / (12 \cdot S)$
 $F = r \cdot L / 2 - c \cdot (r - h) / 2$

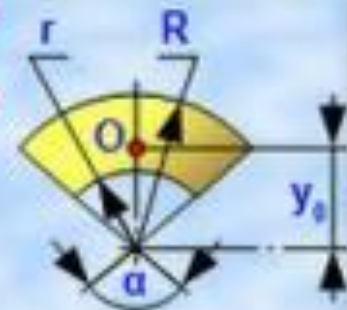


parallelogramm uchun



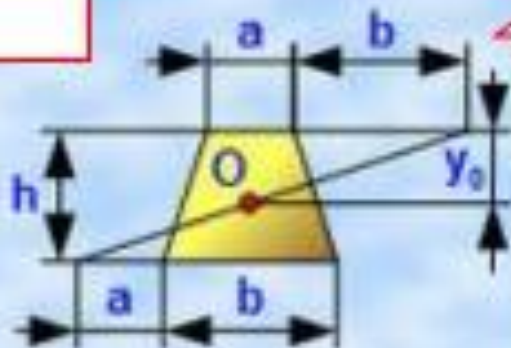
xalqa uchun

$y_0 = 4 \cdot (R^3 - r^3) \cdot \sin(\alpha/2) / (3 \cdot (R^2 - r^2) \cdot \alpha)$
 $F = a/2 \cdot (R^2 - r^2)$



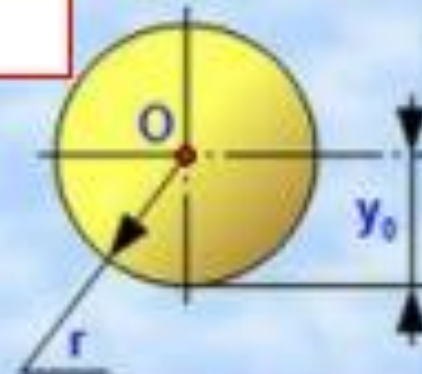
ba'zi bir jinsli jismlarning og'irlik markazlari

trapetsiya



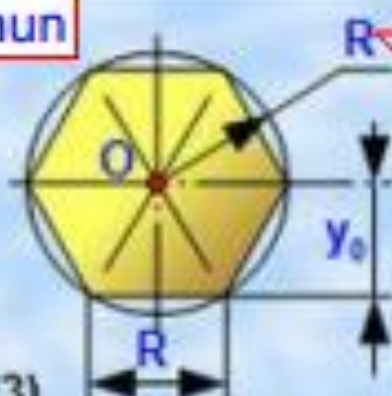
$$y_0 = \frac{h}{3} \cdot \frac{2a + b}{a + b}$$
$$F = \frac{(a + b) \cdot h}{2}$$

aylana uchun



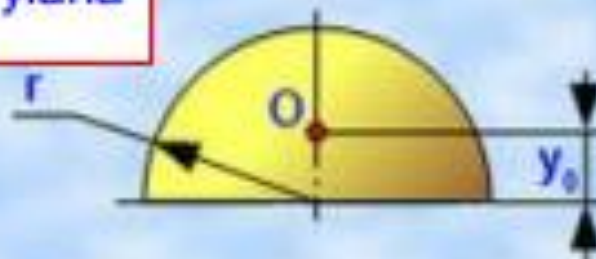
$$y_0 = r$$
$$F = \pi \cdot r^2$$

beshburchak uchun



$$y_0 = R \cdot \sin(\pi/3)$$
$$F = 3 \cdot (R^2) \cdot \sin(\pi/3)$$

yarim aylana uchun



$$y_0 = \frac{4 \cdot r}{3 \cdot \pi}$$
$$F = \left(\frac{\pi}{2}\right) \cdot r^2$$

ba'zi bir jinsli jismlarning og'irlik markazlari

a) Doiraning, aylananing va sharning og'irlik markazi ularning geometrik markazida yotadi.

b) To'g'rito'rtburchak, parallelogramm, rombning og'irlik markazlari ularning diagonallarining kesishgan nuqtasida yotadi.

s) Uchburchak yuzali qattiq jismning og'irlik markazi medianalarining kesishgan nuqtalarida yotadi.

d) Simmetriya tekisligiga, yuzasiga, yoki o'qiga ega bo'lgan figuralarning og'irlik markazlari shu tekislikda, yuzada, o'qda yotadi.

INSERT JADVALI

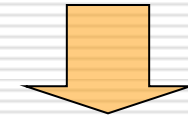
V	+	-	?

Insert jadvali:

- ma'lumotlarni sistemalashtirishni (mustaqil o'qish/ ma'ruza eshitish jarayonida olingan), ularni tasdiklash, aniklashtirish yoki rad etish; qabul qilinayotgan ma'lumotning tushunarligini nazorat qilish, avval egallangan ma'lumotni yangisi bilan bog'lash qobiliyatlarini shakllantirishni ta'minlaydi;

- o'quv ma'lumotini mustaqil o'rganilganidan so'ng qo'llanadi.

Insert jadvalining tuzilishi va uni to'ldirish qoidasi bilan tanishadilar.



O'qish jarayonida olingan ma'lumotlarni individual holda sistemalashtiradilar;

Matnda qo'yilgan belgilar asosida jadval ustunlarini to'ldiradilar:

V - xaqidagi bilimlarimga javob beradi;

«-» - xaqidagi bilimlarimga zid;

+ - yangi ma'lumotlar

? – tushunarsiz (aniqlashtirish, to'ldirishni talab qiladi) ma'lumot.



NAZORAT SAVOLLARI:

1. Ikki parallel kuchning markazi qanday teoremadan foydalanib aniqlanadi?
2. Parallel kuchlar markazining koordinatalari qanday formulalarda ifodalanadi?
3. Qattiq jismning og'irlik markazi koordinatalari qanday ifodalanadi?
4. Hajmga ega bo'lgan bir jinsli jismlarning og'irlik markazi koordinatalarini aniqlash formulalari qanday ifodalanadi?
5. Tekis yuzaga yoki shaklga ega bo'lgan bir jinsli jismlarning og'irlik markazi koordinatalarini aniqlash formulalari qanday ifodalanadi?
6. To'g'ri chiziq shakliga ega bo'lgan bir jinsli jismlarning og'irlik markazi koordinatalarini aniqlash formulalari qanday ifodalanadi?
7. Og'irlik markazini aniqlashning simmetriya usuli qachon qo'llaniladi?
8. Og'irlik markazini aniqlashning bo'laklarga bo'lish usuli qachon qo'llaniladi?
9. Og'irlik markazini aniqlashning manfiy yuzaga (hajm) usuli qachon qo'llaniladi?
10. Og'irlik markazini aniqlashning tajriba usuli qachon qo'llaniladi?
11. Og'irlik markazini aniqlashning integrallash usuli qachon qo'llaniladi?

E'TIBORLARINGIZ UCHUN

RAHMAT!