



O'ZBEKISTON RESPUBLIKASI
OLIV VA O'RTA MAXSUS TA'LIM VAZIRLIGI

TOSHKENT IRRIGATSIYA VA QISHLOQ XO'JALIGINI
MEXANIZATSIYALASH MUHANDISLARI INSTITUTI

«NAZARIY VA QURILISH MEXANIKASI» KAFEDRASI



FAN: NAZARIY MEXANIKA

MA'RUZACHI:

TEXNIKA FANLARI NOMZODI, DOTSENT

Xudaynazarov Sherzod Ochilovich



TOSHKENT-2021



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6-ma'ruza.

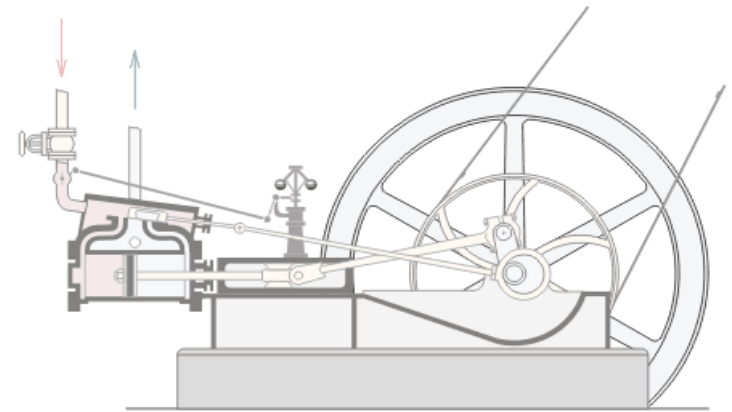
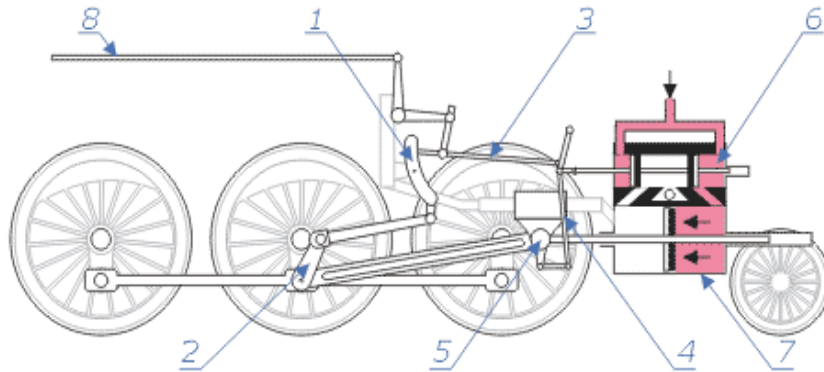
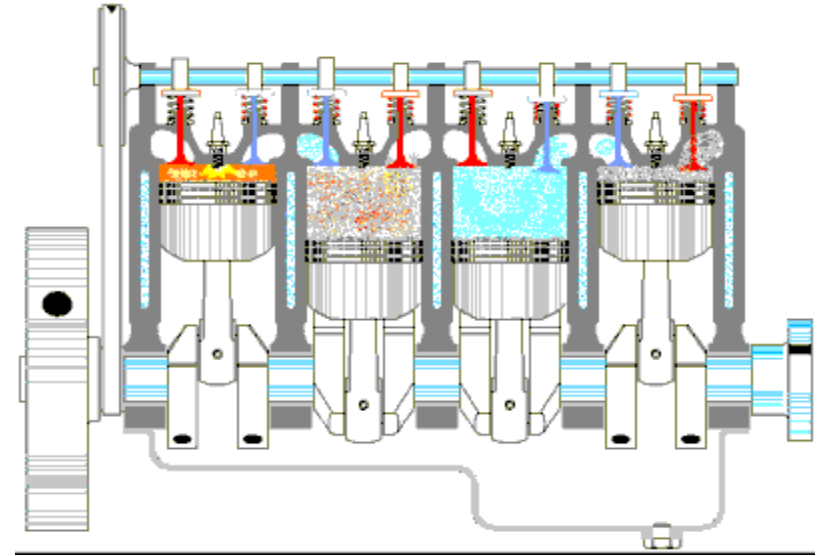
Qattiq jism kinematikasi. Qattiq jismning eng oddiy harakatlari.

REJA:

- 1. Qattiq jismning ilgarilanma harakati.**
- 2. Qattiq jismning qo'zg'almas o'q atrofidagi aylanma harakati.**
- 3. Qattiq jismning tekis parallel harakati.**



QATTIQ JISM KINEMATIKASI



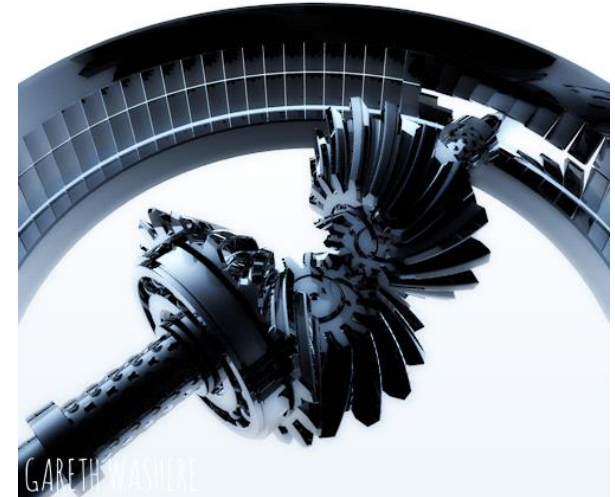
1-rasm

QATTIQ JISM KINEMATIKASI

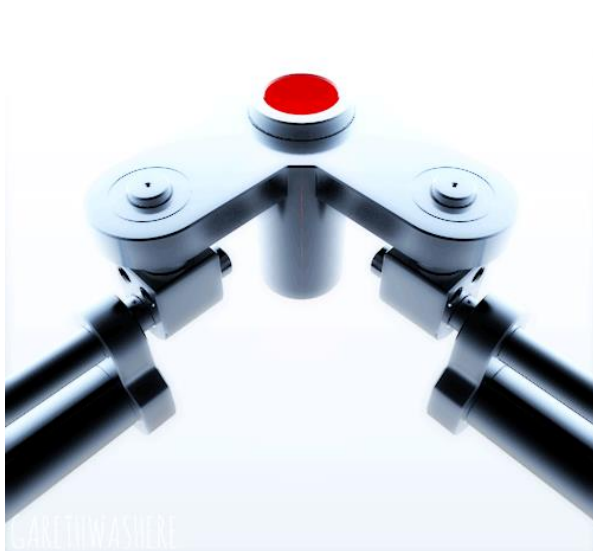
www.turbini.ru



www.turbini.ru



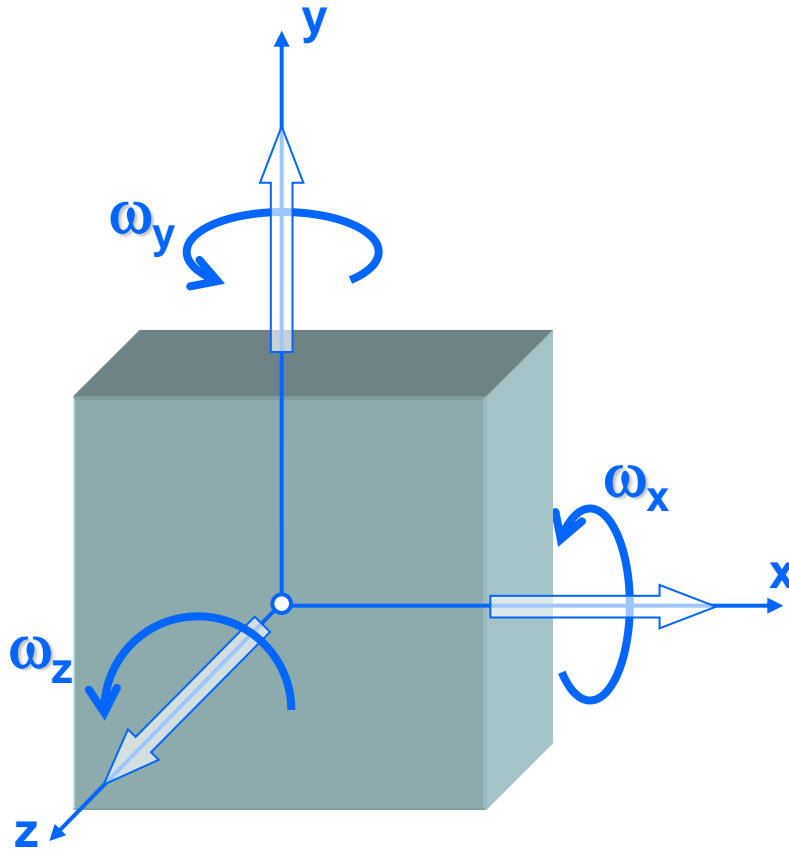
www.turbini.ru



www.turbini.ru



2-rasm



3-rasm



Qattiq jismning ilgari lanma harakati

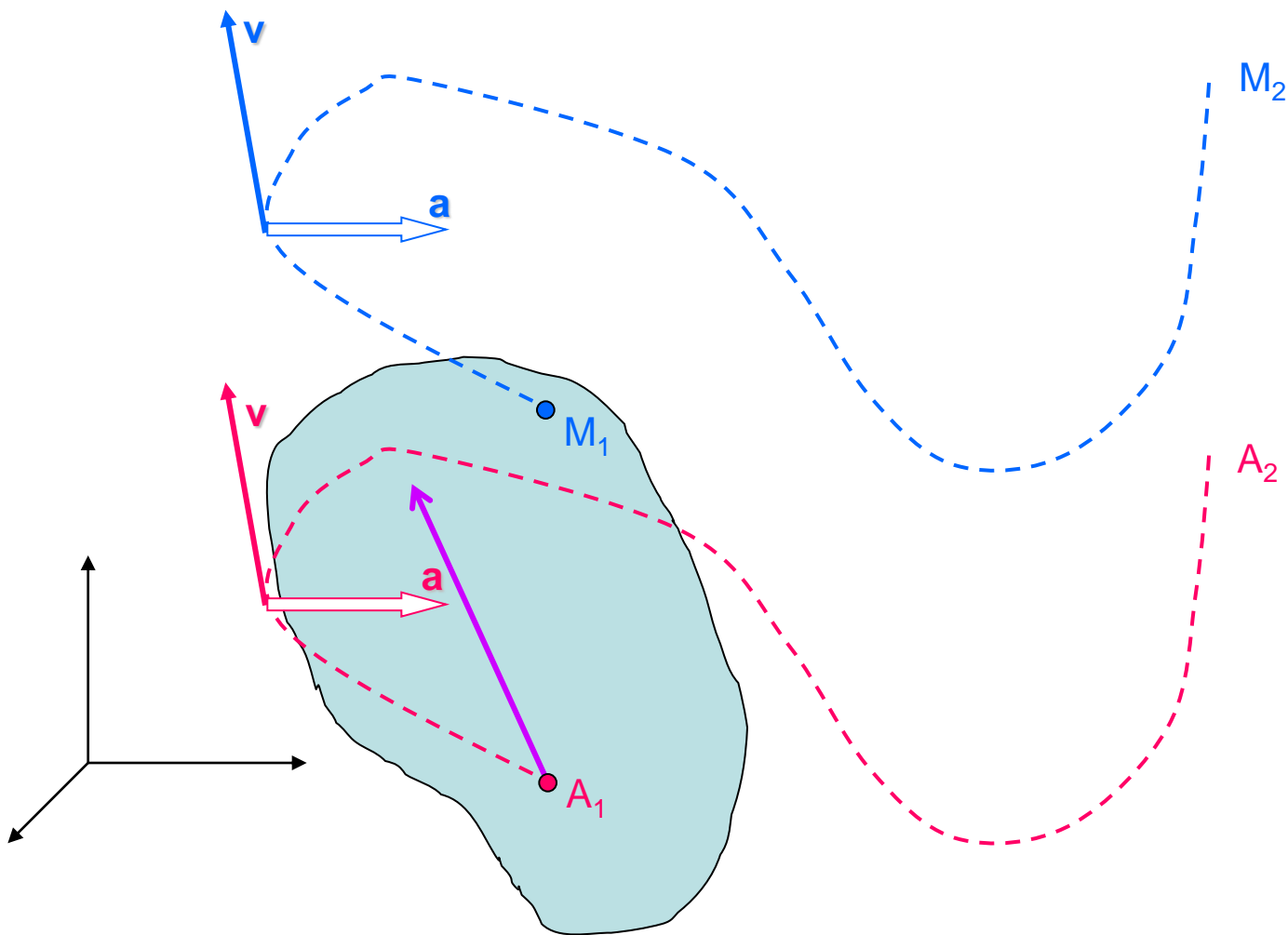
Harakati davomida jismda olingan har qanday ***kesma o'ziga parallel qolsa***, jismning bunday harakatiga ilgari lanma harakat deyiladi.

Ilgari lanma harakat xossasi:



Ilgari lanma harakatdagi jismning hamma nuqtalari **bir xil ko'rinishdagi traektoriya** chizib, ular har onda **bir xil tezlik** va **bir xil tezlanishga** ega bo'ladi.





4-rasm

berilgan: $\vec{r}_A = \vec{r}_A(t)$

ixtiyoriy **N** nuqta uchun

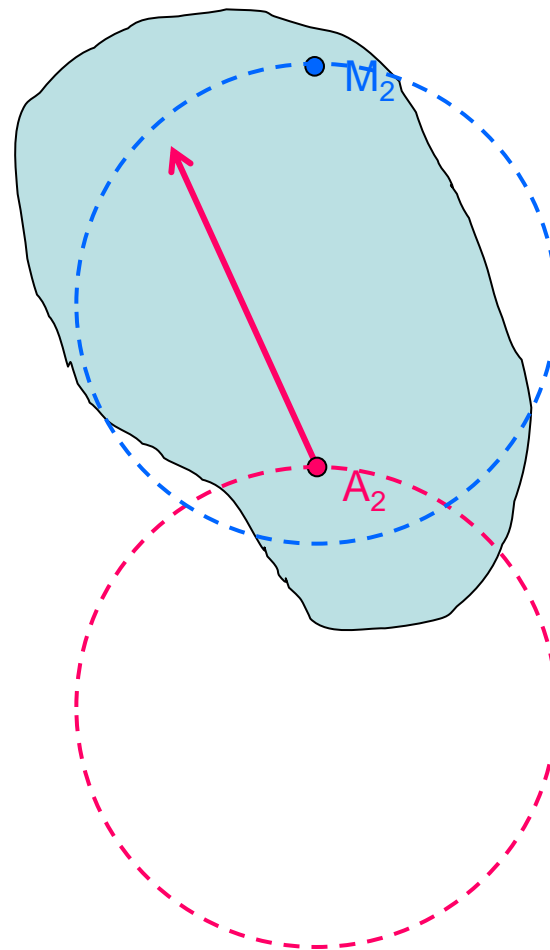
$$\vec{r}_N = \vec{r}_A(t) + \overrightarrow{AN}$$

$$\begin{cases} x_N = x_A(t) + N_x \\ y_N = y_A(t) + N_y \\ z_N = z_A(t) + N_z \end{cases}$$

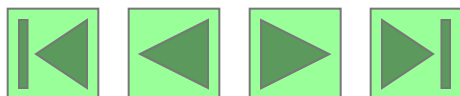
$$\overrightarrow{AN} = N_x \vec{i} + N_y \vec{j} + N_z \vec{k}$$

$$\vec{v}_N = \vec{v}_A = \vec{v}$$

$$\vec{a}_N = \vec{a}_A = \vec{a}$$



5-rasm



berilgan: $\vec{r}_A = \vec{r}_A(t)$

ixtiyoriy **N** nuqta uchun

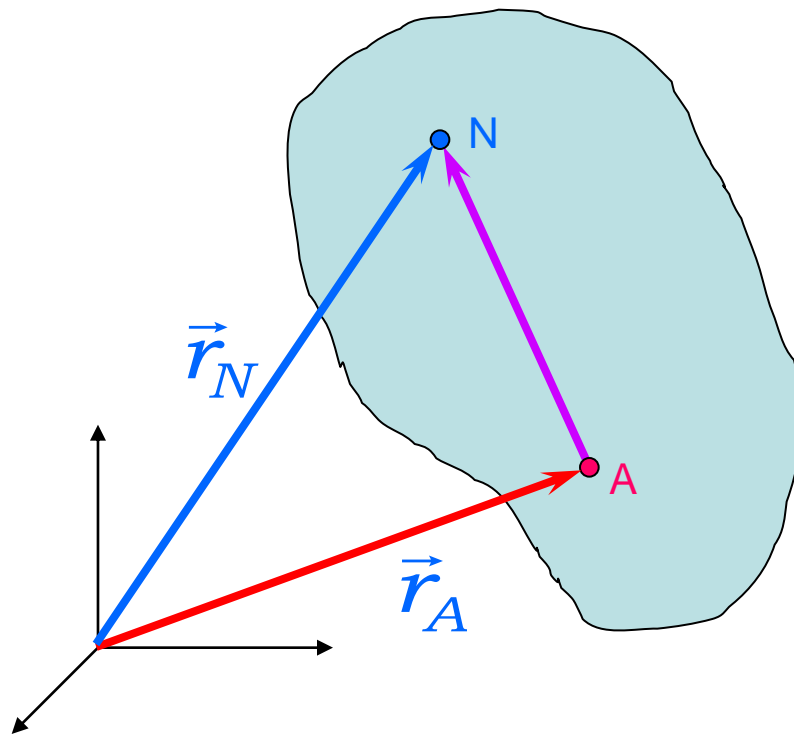
$$\vec{r}_N = \vec{r}_A(t) + \overrightarrow{AN}$$

$$\begin{cases} x_N = x_A(t) + N_x \\ y_N = y_A(t) + N_y \\ z_N = z_A(t) + N_z \end{cases}$$

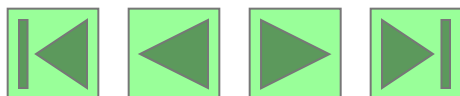
$$\overrightarrow{AN} = N_x \vec{i} + N_y \vec{j} + N_z \vec{k}$$

$$\vec{v}_N = \vec{v}_A = \vec{v}$$

$$\vec{a}_N = \vec{a}_A = \vec{a}$$

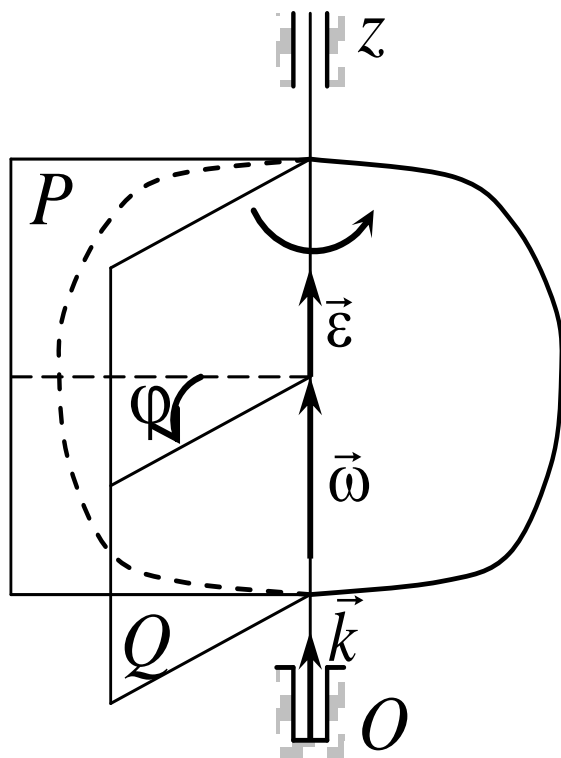


6-rasm



Qattiq jismning qo'zg'almas o'q atrofidagi aylanma harakati

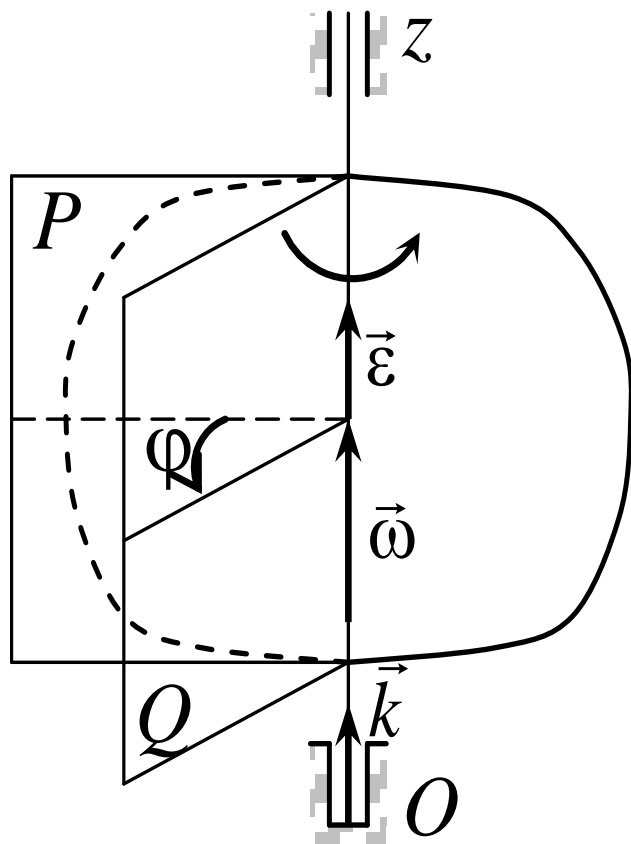
Harakat davomida jismning ikkita nuqtasi doimo qo'zg'almay qolsa, jismning bunday xarakati qo'zg'almas o'q atrofidagi aylanma xarakat deyiladi.



Qattiq jismning qo'zg'almas o'q atrofida aylanma xarakati $\varphi = \varphi(t)$

tenglama bilan to'liq ifodalanadi.

Bu ifoda jismning qo'zg'almas o'q atrofida aylanma harakati tenglamasi deyiladi.



8-rasm

Burilish burchagining vaqt birligida o'zgarishiga jismning **burchak tezligi** deyiladi:

$$\omega = d\varphi / dt = \dot{\varphi}$$

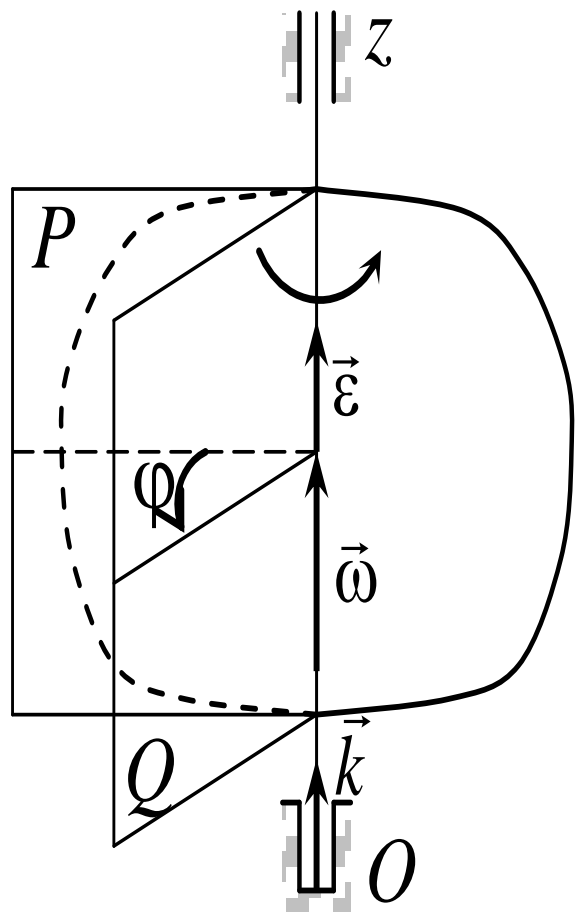
Qattiq jismning **burchak tezligi** shartli ravishda aylanish o'qi bo'yicha yo'nalgan va uning musbat uchidan qaraganda aylanish soat strelkasi harakatiga teskari ko'rinadigan **vektor** deb qaraladi.

Qattiq jismning burchak tezligi doimo o'zgarmay qoladigan harakat tekis aylanma harakat deyiladi. Bunda tezlik ifodasini integrallab, harakat qonunini hosil qilish mumkin:

$$\varphi = \varphi_0 + \omega t$$

Burchak tezlikning vaqt birligida o'zgarishi jismning ***burchak tezlanishi*** deyiladi:

$$\varepsilon = d\omega / dt = \ddot{\varphi}$$



Burchak tezlanish o'zgarmay qoladigan harakatga tekis o'zgaruvchan aylanma harakat deyiladi. bunda tezlanish ifodasini ikki marta integrallab, burchak tezlik va xarakat qonunini topish mumkin:

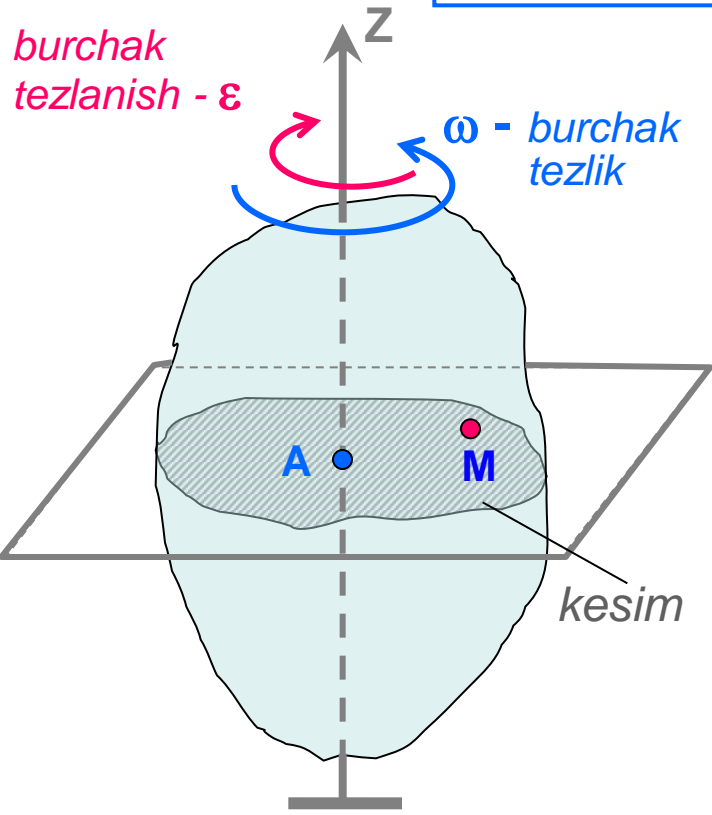
$$\omega = \omega_0 + \varepsilon t \quad \varphi = \varphi_0 + \omega_0 t + \varepsilon t^2 / 2$$

9-rasm

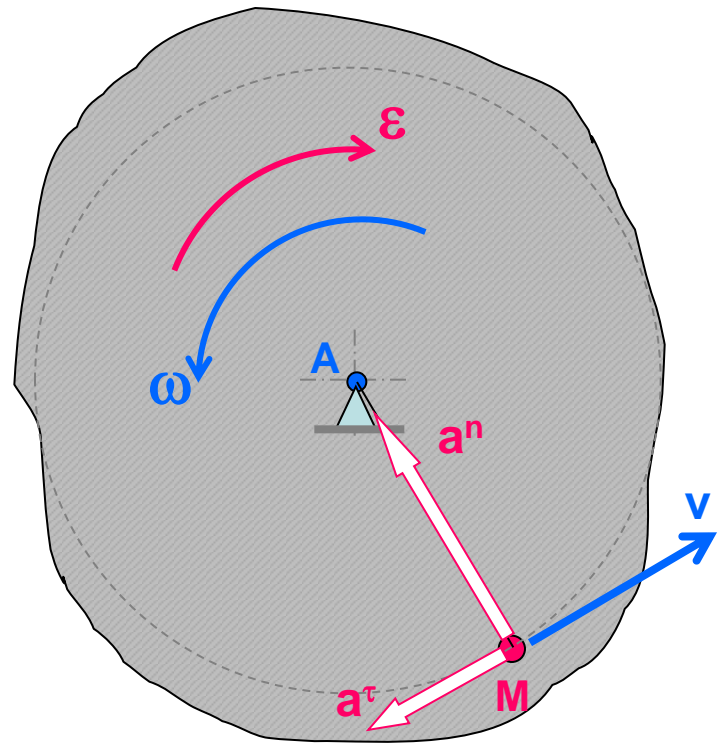
$$V = \omega \cdot AM$$

$$a^n = \omega^2 \cdot AM$$

$$a^\tau = \varepsilon \cdot AM$$

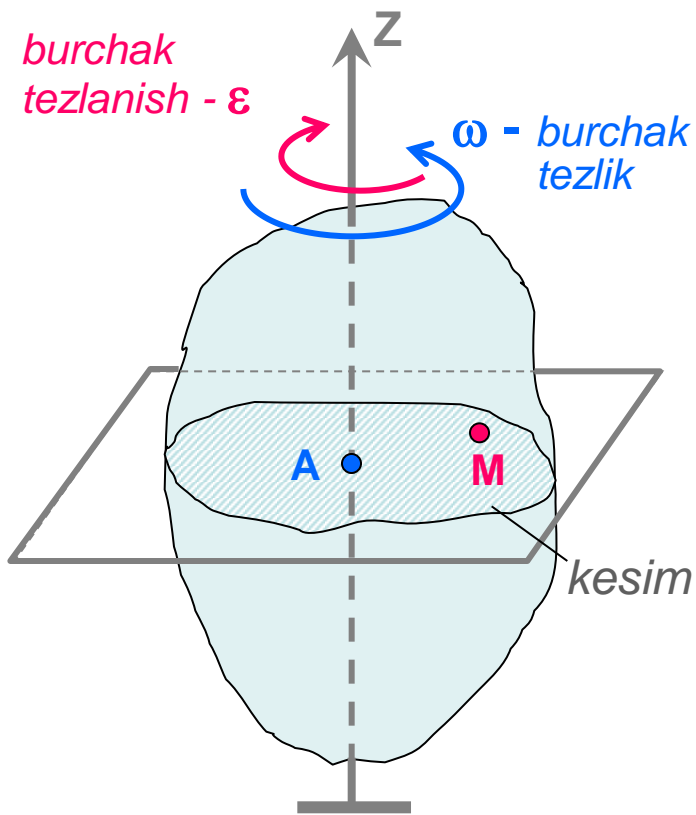


10-rasm



11-rasm

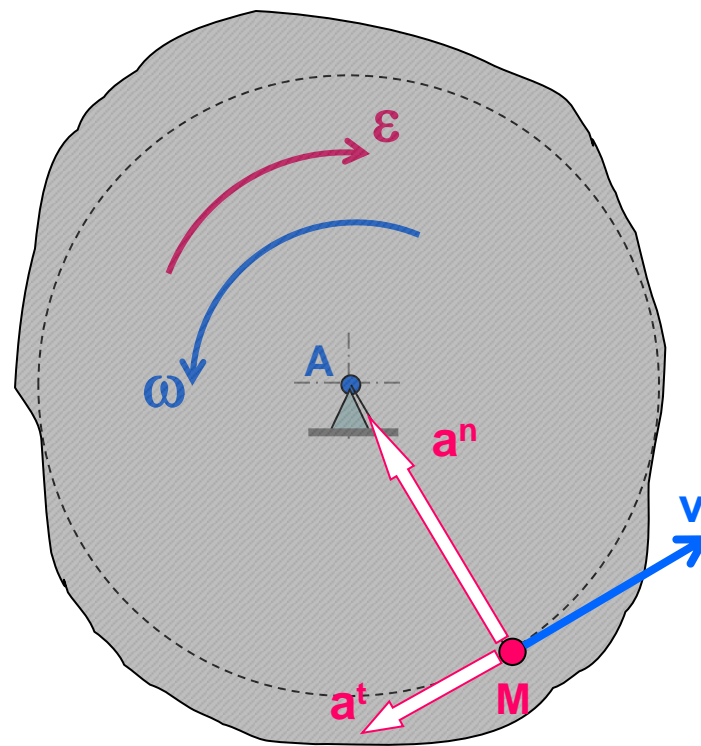




12-rasm



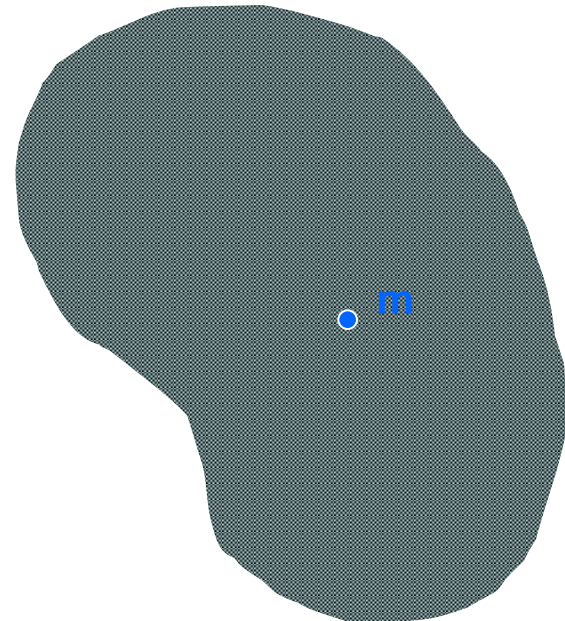
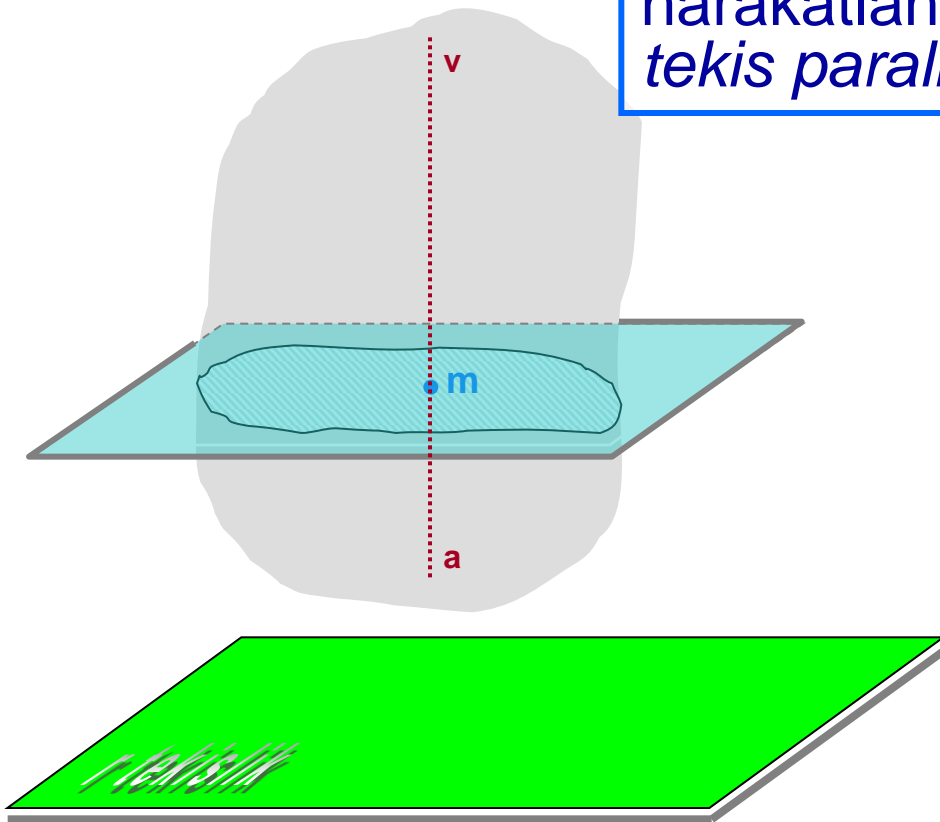
ushbu tugmani bosing!



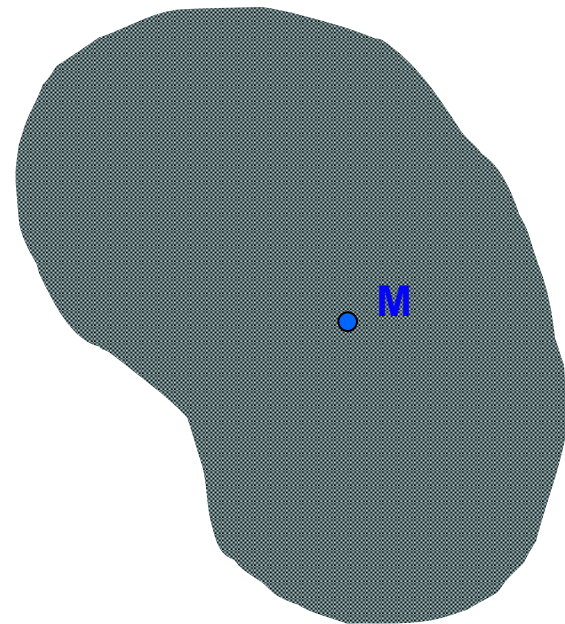
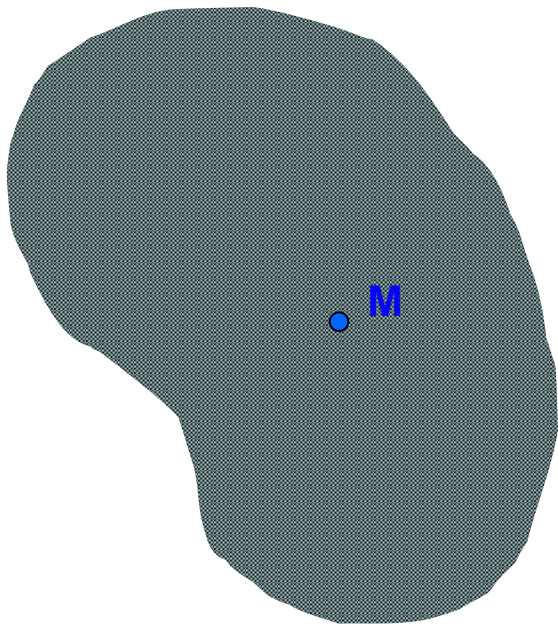
13-rasm

Tekis parallel harakat modeli

Jismning har bir nuqtasi biror qo'zg'almas tekislikka nisbatan parallel tekislikda harakatlansa, jismning bunday harakati *tekis parallel harakat* deyiladi.



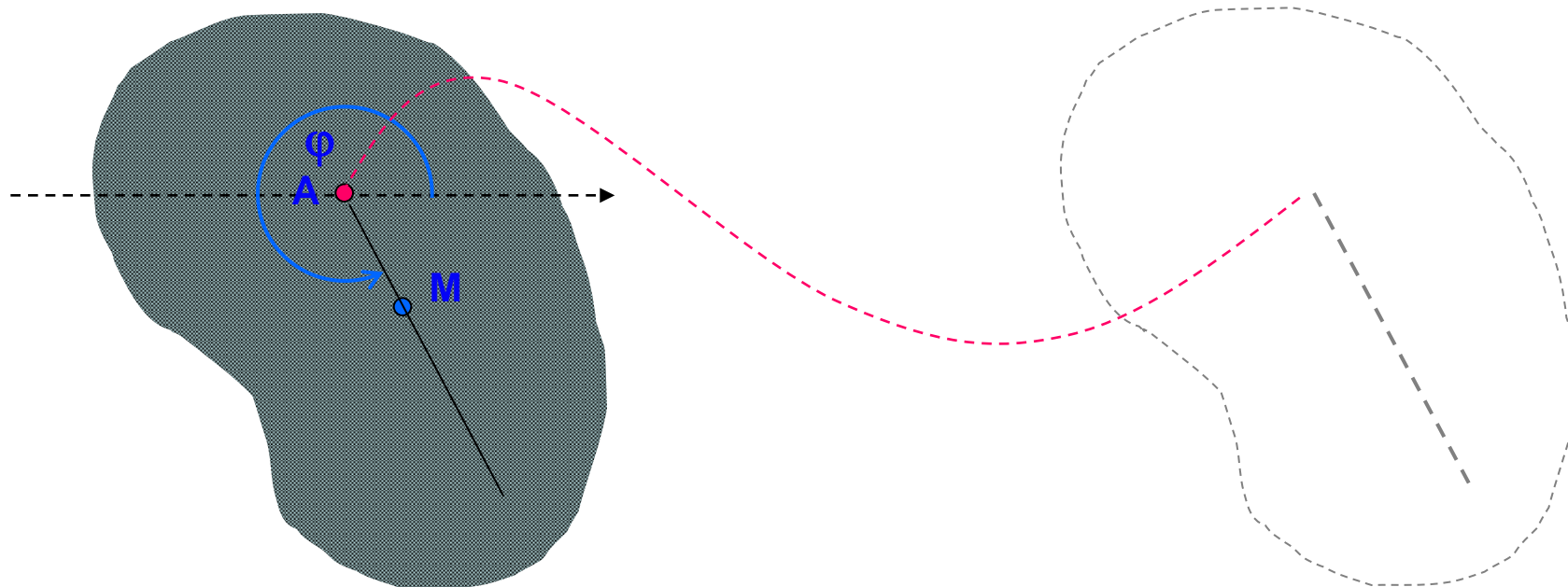
Tekis parallel harakat modeli



15-rasm

Tekis parallel harakat modeli

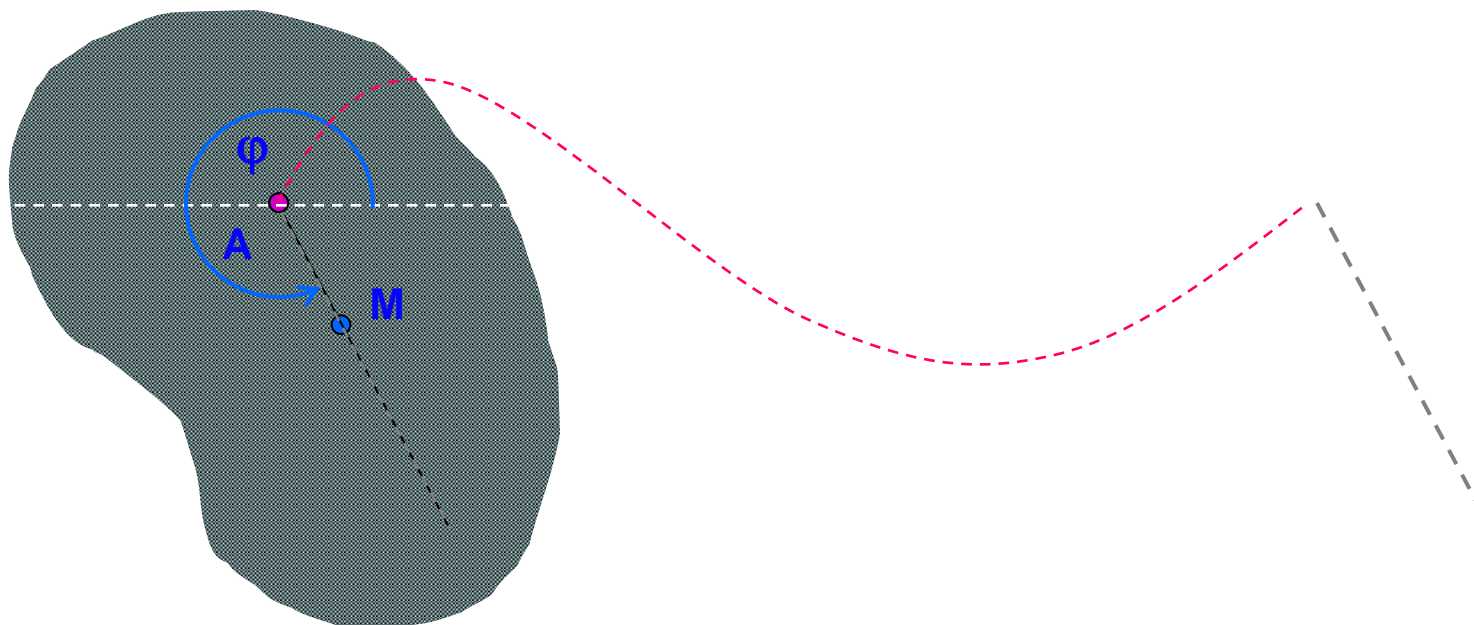
A - nuqta qutb nuqtasi



16-rasm

Tekis parallel harakat modeli

A - nuqta qutb nuqtasi



17-rasm

Tekis parallel harakat modeli

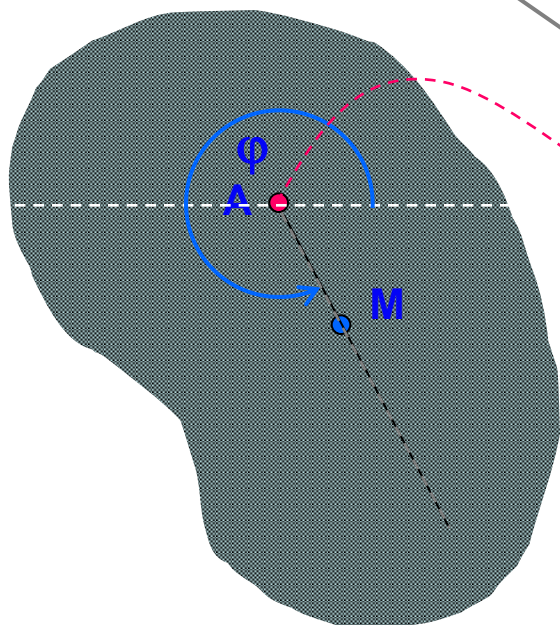
qutbning harakat qonuni

qutb atrofida aylanma harakat qonuni

$$\mathbf{x}_A = \mathbf{x}_a(t)$$

$$\mathbf{y}_A = \mathbf{y}_a(t)$$

$$\varphi = \varphi(t)$$

Qattiq jismning tekis parallel harakat qonuni

Qattiq jismning tekis parallel harakati

Tekis parallel harakat modeli

Qutbning harakat qonuni

$$\mathbf{x}_A = \mathbf{x}_a(t)$$

Qutb atrofida aylanma harakat qonuni

$$\mathbf{y}_A = \mathbf{y}_a(t)$$

$$\varphi = \varphi(t)$$

Qutbning harakati figuraning (jismning) ilgarilanma harakat qismini ifodalaydi.

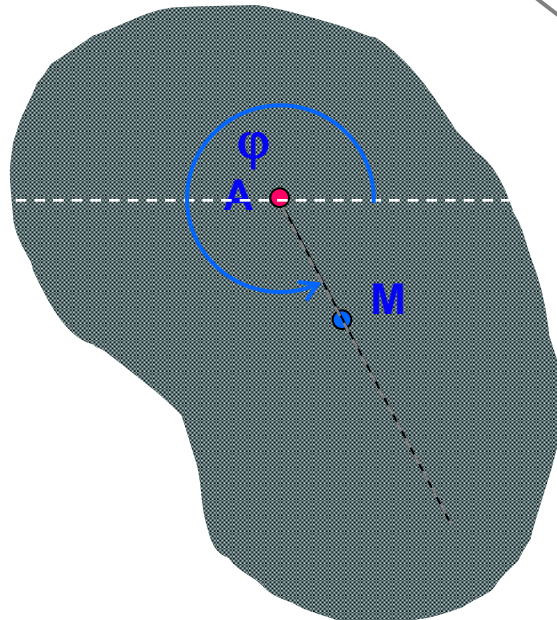


$$\mathbf{v}_A$$



$$\mathbf{a}_A$$

Bu jismning qutb bilan ilgarilanma harakat tezligi va tezlanishidir.



φ burchakning o'zgarishi figura (jism) harakatining aylanma harakat qismini aniqlaydi.



$$\omega$$



$$\varepsilon$$

Bu figuraning qutb atrofida aylanma harakati tezligi va tezlanishidir.

19-rasm



Ixtiyoriy nuqtaning traektoriyasi

Qutbning harakat qonuni

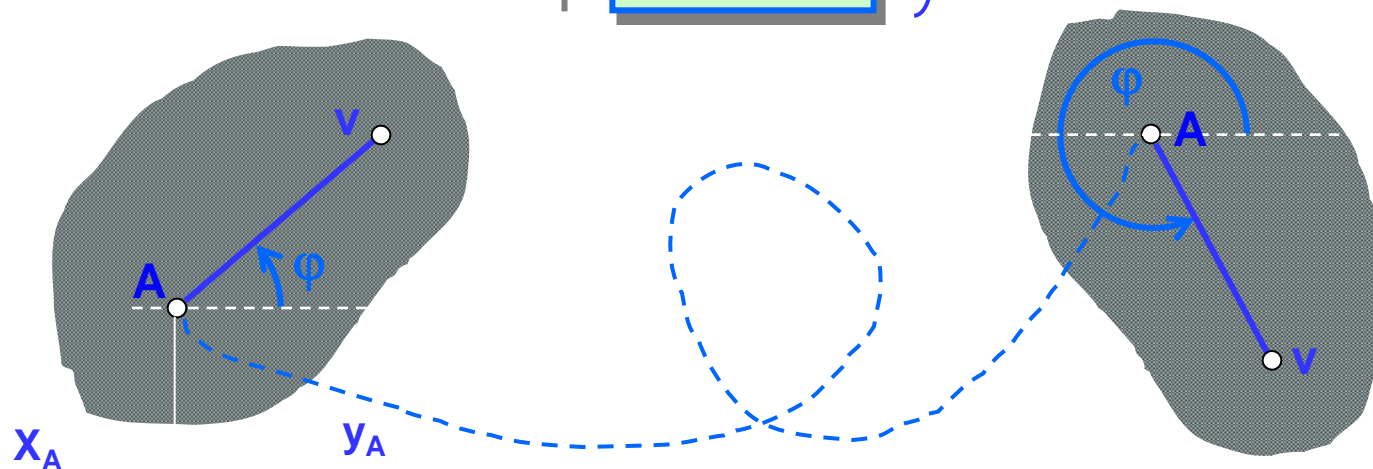
$$x_A = x_a(t)$$

Qutb atrofida aylanma harakat qonuni

$$y_A = y_a(t)$$

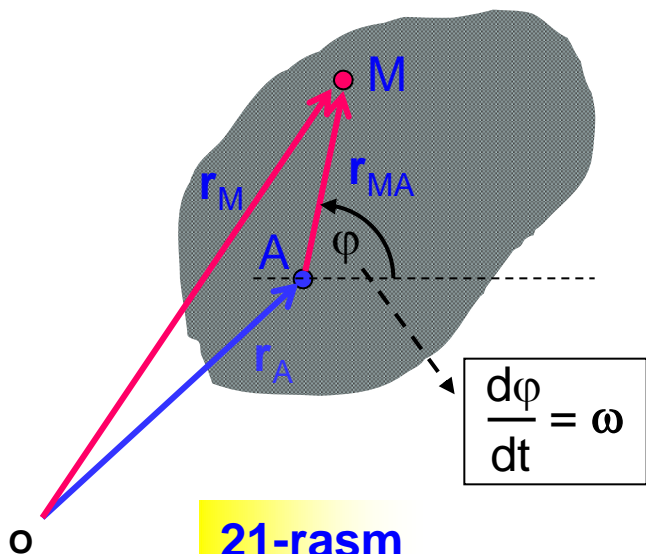
$$\varphi = \varphi(t)$$

Qattiq jismning tekis parallel harakat qonuni

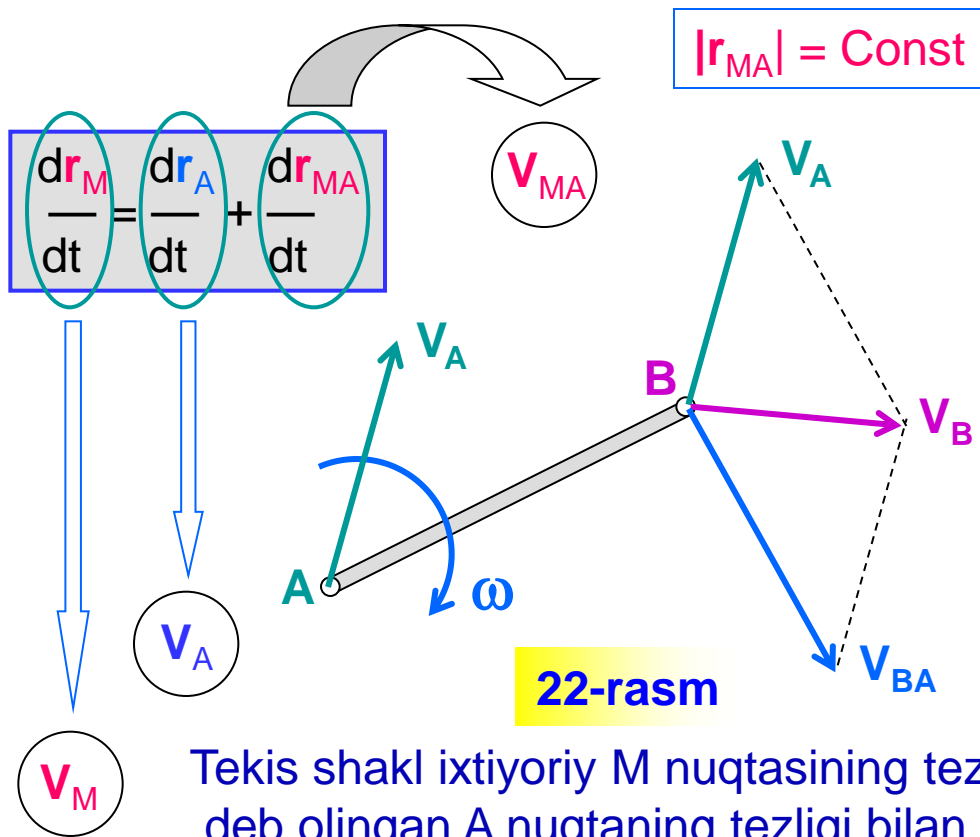


Ixtiyoriy nuqta tezligi

$$\mathbf{r}_M = \mathbf{r}_A + \mathbf{r}_{MA}$$



21-rasm



22-rasm

Tekis shakl ixtiyoriy M nuqtasining tezligi qutb deb olingan A nuqtaning tezligi bilan mazkur m nuqtaning qutb atrofida aylanishidagi chiziqli tezligining vektor (geometrik) yig'indisiga teng.

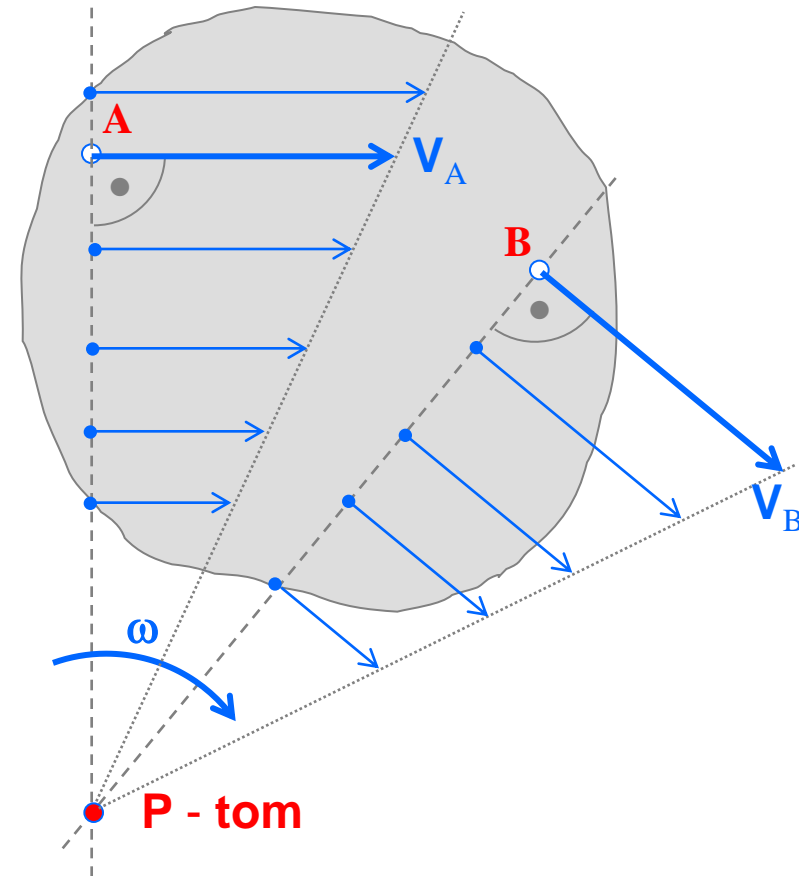
$$\mathbf{V}_M = \mathbf{V}_A + \mathbf{V}_{MA}$$



Tezliklar oniy markazi

Burchak tezligi noldan farqli tekis shaklning berilgan onda **tezligi nolga teng** bo'lgan nuqtasi tezliklar oniy markazi (**tom**) deyiladi.

Biror onda tom ma'lum bo'lgan tekis shakl nuqtalarining shu ondagi tezliklarini tom atrofida xuddi **oddiy aylanma harakatdagi jism** nuqtalarining tezliklari kabi topiladi. Tekis shakl nuqtalarining tezliklari shu nuqtalardan tomgacha bo'lgan masofaga to'g'ri proporsionaldir.



23-rasm



Tekis shakl ixtiyoriy nuqtasining tezlanishi

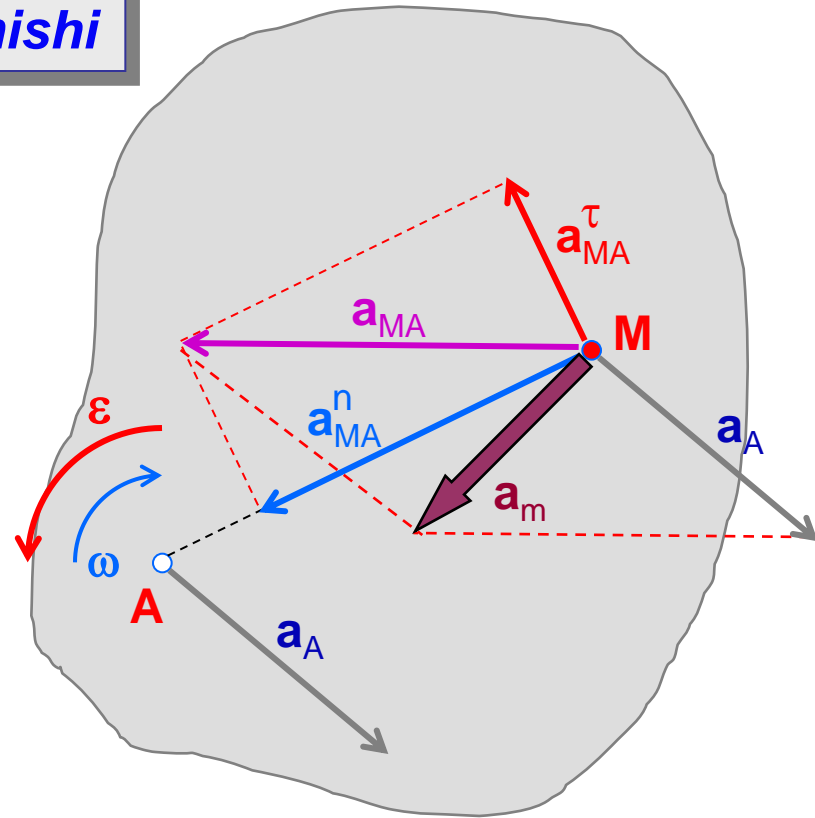
Tekis shakl ixtiyoriy M nuqtasining tezlanishi qutb deb olingan A nuqtaning tezlanishi bilan mazkur M nuqtaning qutb atrofida aylanishidagi chiziqli tezlanishining vektor (geometrik) yig'indisiga teng.

$$\mathbf{a}_M = \mathbf{a}_A + \mathbf{a}_{MA}$$

$$\mathbf{a}_M = \mathbf{a}_A + \mathbf{a}_{MA}^n + \mathbf{a}_{MA}^\tau$$

$$a_{MA}^n = \omega^2 \cdot AM$$

$$a_{MA}^\tau = \varepsilon \cdot AM$$



24-rasm



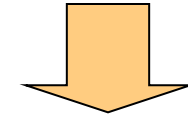
INSERT JADVALI

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. Qattiq jismning qanday harakatiga ilgarilanma harakat deyiladi?
2. Qattiq jismning qanday harakatiga qo'zg'almas o'q atrofidagi aylanma harakat deyiladi?
3. Aylanma harakat tenglamasi qanday ko'rinishda bo'ladi?
4. Aylanma harakat qilayotgan qattiq jismning burchak tezlik va burchak tezlanish modullari qanday formula bilan aniqlanadi?
5. Qo'zg'almas o'q atrofidagi aylanma harakat qilayotgan qattiq jism burchak tezlik va burchak tezlanish vektorlari qanday yo'nalgan bo'ladi?
6. Qattiq jismning tekis parallel harakati deb qanday harakatga aytiladi?
7. Tekis parallel harakat tenglamalari qanday ko'rinishda bo'ladi?
8. Qutb deganda nimani tushinasiz?
9. Tekis shakl nuqtasining tezligini qutb yordamida aniqlash formulasi qanday ifodalanadi?
10. Qattiq jismning tekis parallel harakati qanday oddiy harakatlar yig'indisidan iborat bo'ladi?
11. Tekis shaklning qanday nuqtasiga tezliklar oniy markazi deyiladi?
12. Tezliklar oniy markazini aniqlashning qanday usullari mavjud?
13. Qutb yordamida tekis shakl ixtiyoriy nuqtasining tezlanishini aniqlash formulasi qanday ifodalanadi?
14. Tekis shaklning qanday nuqtasiga tezlanishlar oniy markazi deyiladi?
15. Tezliklar oniy markazi bilan tezlanishlar oniy markazi ustma–ust tushadimi?

**E'TIBORLARINGIZ UCHUN
RAHMAT!**