TOSHKENT IRRIGATSIYA VA QISHLOQ XO'JALIGINI MEXANIZATSIYALASH MUHANDISLARI INSTITUTI

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MAVZU 14

Sistema kinetik energiyasining o'zgarishi haqidagi teorema.

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Sistema kinetik energiyasining o'zgarishi haqidagi teorema

$$d\left(\frac{m_k \vartheta_k^2}{2}\right) = \vec{F}_k^{\,e} d\vec{r}_k + \vec{F}_k^{\,i} d\vec{r}_k \Rightarrow d\left(\sum \frac{1}{2} m_k \vartheta_k^2\right) = \sum \vec{F}_k^{\,e} d\vec{r}_k + \sum \vec{F}_k^{\,i} d\vec{r}_k, \quad (k = 1,2,\ldots,N)$$

$$dT = \sum_{k=1}^{N} dA_k^{(e)} + \sum_{k=1}^{N} dA_k^{(i)}$$

$$T = \sum_{k=1}^{N} \frac{m_k \vartheta_k^2}{2}$$

$$T - T_0 = \sum \int_{M_{10}}^{M_1} dA_k^{(e)} + \int_{M_{10}}^{M_1} dA_k^{(i)}$$

$$T - T_0 = \sum A_k^{(e)} + \sum A_k^{(i)}$$

$$T - T_0 = \sum A_k^{(e)}$$

Jismlarning kinetik energiyasini hisoblash

***Kyonig teoremasi*.** Absolyut harakatdagi sistemaning kinetik energiyasi, uning massalar markazining kinetik energiyasi (agar sistemaning massasi, uning massalar markaziga jamlangan deb qaralsa) va massalar markazi bilan birgalikda ilgarilanma harakatdagi koordinatalar sistemasiga nisbatan sistemaning nisbiy harakati kinetik energiyasining yig'indisiga teng, ya'ni :

$$T = \frac{1}{2} M \vartheta_C^2 + T_C^{(r)}$$

Ilgarilanma harakatdagi qattiq jismning kinetik energiyasini hisoblash.

$$T=\sum_{k=1}^{N} m_k \frac{\vartheta_k^2}{2}=\frac{1}{2}M\vartheta_C^2$$

$$T=\frac{1}{2}\sum_{k=1}^{N} m_k\vartheta_k^2=\frac{1}{2}\sum_{k=1}^{N} m_k\left(\omega h_k\right)^2=\frac{1}{2}\omega^2\cdot\sum_{k=1}^{N} m_k h_k^2=\frac{1}{2}I_z\omega^2$$

$$T=\frac{1}{2}I_z\omega^2 \qquad I_z=\sum_{k=1}^{N} m_k h_k^2$$

Tekis parallel harakatdagi qattiq jismning kinetik energiyasini hisoblash.

$$T=\frac{1}{2}I_{cz}\omega^2+\frac{1}{2}Md^2\omega^2$$

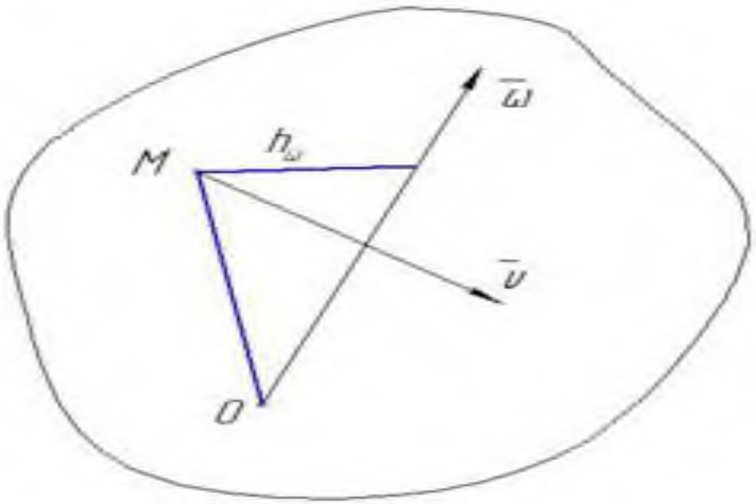
$$T=\frac{1}{2}M\vartheta_c^2+\frac{1}{2}I_{cz}\omega^2,$$

Sferik harakatdagi qattiq jismning kinetik energiyasini hisoblash

$$T = \frac{1}{2}(I_x\omega_x^2 + I_y\omega_y^2 + I_z\omega_z^2 - 2I_{yz}\omega_y\omega_z - 2I_{zx}\omega_z\omega_x - 2I_{xy}\omega_x\omega_y),$$

ω_x, ω_y, ω_z - oniy burchak tezlikning qo'z'aluvchan koordinata o'qlaridagi proeksiyalari;

J_{yz}, J_{xy}, J_{zx} - jismning markazdan qochuvchi momentlari.



Potensial kuch maydoni

Ta'rif. Kuch maydoni deb, fazoning shunday qismiga aytiladiki, bunda har bir nuqtaga koordinata va vaqtning funksiyasiga bog'liq bo'lgan kuch ta'sir qiladi.

Agar berilgan kuch vaqtga bog'liq bo'lmasa, u holda kuch maydoni statsionar kuch maydoni deyiladi.

Agar berilgan kuch vaqtga bog'liq bo'lsa, u holda kuch maydoni statsionar bo'lmagan kuch maydoni deyiladi.

Agar statsionar bo'lmagan kuch maydoni uchun koordinataga va vaqtga bog'liq bo'lgan *U* kuch funksiyasi mavjud bo'lsa, u holda kuch maydoni potensial kuch maydoni deyiladi. Kuch maydoniga kiritilgan nuqtaga ta'sir qiluvchi kuchning koordinata o'qlariga proeksiyalarini *U* kuch funksiyasi orqali ifodalasak quyidagicha yoziladi:

$$F_x = \frac{\partial U}{\partial x}; \quad F_y = \frac{\partial U}{\partial y}; \quad F_z = \frac{\partial U}{\partial z}.$$

Endi kuch funksiyasining hossalarini ko'ramiz.

$$dA = F_x dx + F_y dy + F_z dz = \frac{\partial U}{\partial x}dx + \frac{\partial U}{\partial y}dy + \frac{\partial U}{\partial z}dz = dU, \quad \Rightarrow \quad dA = dU$$

$$A = \int_{M_0}^{M} dA = \int_{M_0}^{M} dU = U(x,y,z) - U(x_0,y_0,z_o) = U - U_0 \quad \Rightarrow \quad A = U - U_0$$

$$qradU = \vec{i}\cdot\frac{\partial U}{\partial x} + \vec{j}\cdot\frac{\partial U}{\partial y} + \vec{k}\cdot\frac{\partial U}{\partial z}, \quad \Rightarrow \quad \vec{F} = gradU$$

$$\frac{\partial F_x}{\partial y} = \frac{\partial^2 U}{\partial y\cdot\partial x}; \qquad \frac{\partial F_y}{\partial x} = \frac{\partial^2 U}{\partial x\cdot\partial y}. \qquad \frac{\partial^2 U}{\partial y\cdot\partial x} = \frac{\partial^2 U}{\partial x\cdot\partial y} \qquad \frac{\partial F_x}{\partial y} = \frac{\partial F_y}{\partial x} \qquad \frac{\partial F_x}{\partial y} - \frac{\partial F_y}{\partial x} = 0$$

$$\frac{\partial F_x}{\partial y} - \frac{\partial F_y}{\partial x} = 0; \quad \frac{\partial F_z}{\partial y} - \frac{\partial F_y}{\partial z} = 0; \quad \frac{\partial F_x}{\partial z} - \frac{\partial F_z}{\partial x} = 0$$

$$rot\,\vec{F} = \vec{i}\left(\frac{\partial F_z}{\partial y} - \frac{\partial F_y}{\partial z}\right) + \vec{j}\left(\frac{\partial F_x}{\partial z} - \frac{\partial F_z}{\partial x}\right) + \vec{k}\left(\frac{\partial F_x}{\partial y} - \frac{\partial F_y}{\partial x}\right) \qquad rot\vec{F} = 0$$

Shunday qilib, kuch maydoni potensialli bo'lishi uchun, kuch maydoni uyurmasiz bo'lishi zarur va yetarli.

Ta'rif. Kuch maydonining *M* nuqtasidagi potensial energiya deb, maydon kuchining nuqta *M* holatdan boshlang'ich M_0 holatga ko'chishidagi ishini ifodalovchi kattalikka aytiladi. Potensial energiyani *P* bilan belgilasak, ta'rifga asosan

$$\Pi = \int_{M}^{M_0} \overline{F} \cdot d\vec{r} = \Pi_0 - \Pi \qquad A = U - U_0 = \Pi_0 - \Pi$$

Agar koordinatalar boshi uchun nuqtaning boshlang'ich holatida olinsa, $\Pi = - U$

kelib chiqadı, ya nı potensial kuch maydonining biror nuqtasidagi potensial energiya shu nuqtadagi kuch funksiyasining teskari ishora bilan olingan qiymatiga teng.

$$P(x_1, u_1, z_1, x_2, y_2, z_2, \ldots, x_n, y_n, z_n) = - U(x_1, u_1, z_1, x_2, y_2, z_2, \ldots, x_n, y_n, z_n)$$

Moddiy nuqta va moddiy nutalar sistemasi uchun mexanik energiyaning saqlanish qonuni

Aytaylik, moddiy nuqta potensial kuch maydonida harakatlansin. U holda

$$\frac{1}{2}m\vartheta^2-\frac{1}{2}m\vartheta_0^2=A, \quad \Rightarrow \quad \frac{1}{2}m\vartheta^2-\frac{1}{2}m\vartheta_0^2=\Pi_0-\Pi$$