USE OF INTERACTIVE METHODS IN EXPRESSING THE EQUATIONS OF MOTION IN THE CYLINTRICAL COORDINATE SYSTEM

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Annotatsiya: Connections between the coordinate system, the radius vector, the velocity vector and the acceleration vector can be cited as concepts that are important in mastering all topics in theoretical mechanics.

Key words: Coordinate system, radius vector, velocity vector, equation of motion, "metreshka method"

It is not a secret to anyone that today a desired science is rapidly developing. If we look closely at the voluntary sector, it is possible to notice new changes. This, in turn, creates the need to ensure that our young people receive education in accordance with the rapid changes in development. It is necessary for our youth to understand that great knowledge lies at the foundation of achievements, especially in concrete and natural sciences, and educators should help in this regard. If we look at the achievements in physics from this point of view, it is based on strong fundamental knowledge. We can show the theoretical courses of physics as a course that is difficult to master. It is no exaggeration to say that only if the theoretical courses are well mastered, the essence of physics will be fully understood and the achievements of the science will be reached.

Any movement in nature is relative. It is necessary to choose a coordinate system to represent the movement of the body. Otherwise, whether the point is moving or the observer remains abstract. Therefore, the appropriate coordinate system is selected for movements with different trajectories.

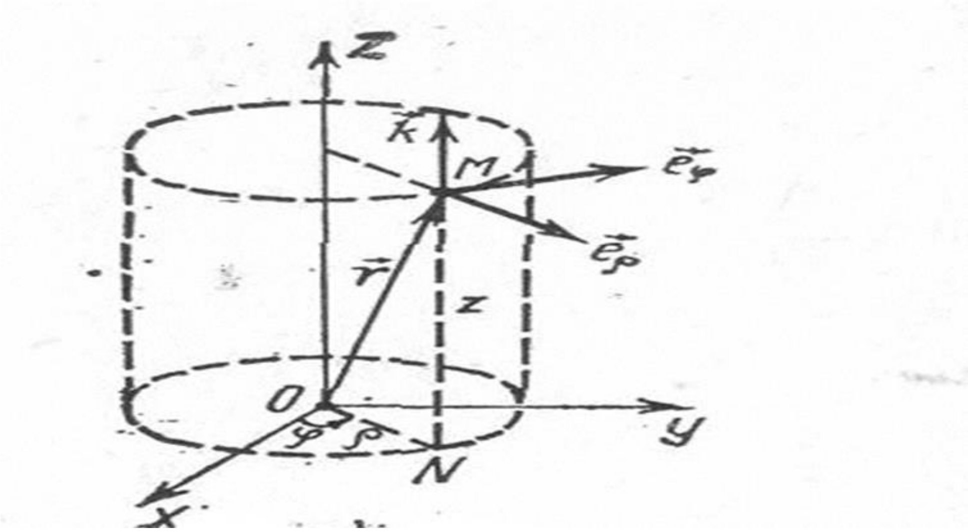
The following coordinate systems are addressed in the theoretical mechanics course: Cartesian coordinate system, cylindrical coordinate system, spherical coordinate system, and polar coordinate system.

There are processes for which it is inconvenient to use the Cartesian coordinate system in the formulation of the equations of motion. For example: changes in liquid crystals, changes in biological fluids in a centrifuge are convenient to see in cylindrical coordinates.

In the cylindrical coordinate system, the position of point M is determined by the coordinates ρ, φ, z . Laws of motion of a point

$$\rho = \rho(t), \quad \varphi = \varphi(t), \quad z = z(t) \qquad (1)$$

will be in appearances.



Update pictures

Cartesian coordinates can be written in cylindrical coordinates as follows.

$$x = \rho\cos\varphi, \quad y = \rho\sin\varphi, \quad z = z \qquad (2)$$

$$\vec{r} = \rho \cdot \vec{e}_\rho + z\vec{k} = x\vec{i} + y\vec{j} + z\vec{k} \qquad (3)$$

To find the connection between $\vec{e}_\rho, \vec{e}_\varphi$ the coordinates of the cylindrical coordinate system and $\vec{i}, \vec{j}$ the Cartesian coordinates we mutually equate expressions (3) in both $\vec{r}$ radius-vector systems and, taking into account (2), we get the following connections:

$$\vec{r} = \rho \cdot \vec{e}_\rho + z\vec{k} = x\vec{i} + y\vec{j} + z\vec{k} = \cos\varphi\vec{i} + \sin\varphi\vec{j} + z\vec{k} \qquad (4)$$

What is this

$$\vec{e}_\rho = \vec{i}\cos\varphi + \vec{j}\sin\varphi, \quad \vec{e}_\varphi = \frac{d\vec{e}_\rho}{d\varphi} = -\vec{i}\sin\varphi + \vec{j}\cos\varphi \qquad (5)$$

we will have results.

To convert from radius vector to speed, it is necessary to take derivative of radius vector with respect to time

$$\vec{v} = \dot{\vec{r}} = \dot{\rho}\vec{e}_\rho + \rho\dot{\vec{e}}_\rho + \dot{z}\vec{k} = \dot{\rho}\vec{e}_\rho + \rho\left(\frac{d(\cos\varphi\vec{i} + \sin\varphi\vec{j})}{dt}\right) + \dot{z}\vec{k} \qquad (6)$$

It appears. This is where most students make a mistake. (5) is derived from the simple function. But (6) is the derivative of a complex function. In this case, using the matreshka method gives its effective result. Here φ the function also changes according to t. In this case, the following is appropriate $\vec{e}_\rho(\varphi(t))$. We use the "Matryushka" method to calculate the product. This method is as follows:

$F(q(k(r(x)))'_x$ if we take the derivative of the function with respect to x $F'_q \times q'_k \times k'_r \times r'_x$ looks like. By opening each parenthesis, the derivative is obtained from the previous function with respect to the visible function. It reminds me of a Russian matryoshka. Let's number the matryoshka dolls in Figure 1 consecutively as 1, the smallest one. We apply to the derivation problem as follows: derivative of matryoshka 5 by matryoshka 4, derivative of matryoshka 4 by matryoshka 3, derivative of matryoshka 3 by matryoshka 2 and derivative of matryoshka 2 by matryoshka 1 . It is similar to the derivative of the complex function above. $\vec{e}_\rho(\varphi(t))$ it is necessary to take a derivative from a function that looks like.

If we use this method, we will have the following.

$$\dot{\vec{e}}_\rho = \dot{\varphi}(-\vec{i}\sin\varphi + \vec{j}\cos\varphi) = \dot{\varphi}\cdot\vec{e}_\varphi,$$

$$\dot{\vec{e}}_\varphi = -\dot{\varphi}(\vec{i}\cos\varphi + \vec{j}\sin\varphi) = -\dot{\varphi}\cdot\vec{e}_\rho$$

$$\dot{\vec{e}}_\rho = \dot{\varphi}\cdot\vec{e}_\varphi, \qquad \dot{\vec{e}}_\varphi = -\dot{\varphi}\cdot\vec{e}_\rho \qquad (7)$$

We can determine the velocity and acceleration vectors if we take into account the equations (14) in the time derivatives of the radius vector of the point (6).

$$\vec{v} = \dot{\rho}\vec{e}_\rho + \rho\dot{\varphi}\vec{e}_\varphi + \dot{z}\vec{k} \qquad (8)$$

we get the expression of acceleration in the form.

Derivatives of this form are formed both in spherical coordinates and in polar coordinates. Explaining to students the derivative of a complex function in the "matryoshka" method increases the mastery rate. In addition, the connection between the trajectory, speed, and acceleration of a material point in all coordinate systems is important. Because Lagrange's formalism, which is one of the most basic concepts of the course of theoretical mechanics, and the connection between the radius vector, speed and acceleration in oscillating movements are of great importance. Therefore, it is necessary to create deep knowledge in students about this connection. It is appropriate to use the "matryoshka" method.

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