IJDPP

International Journal of Development and Public Policy

| e-ISSN: 2792-3991 | www.openaccessjournals.eu | Volume: 1 Issue: 6

Complex Motion of a Point

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Annotation: This paper describes the complex motions of a material point in the kinematics section of theoretical mechanics.

Key words: kinematics, material point, moving stationary.

Today, like all sciences, kinematics is very important. The development of every subject is our biggest responsibility to teachers.

In many cases it is necessary to study the motion of a point with respect to two or more coordinate systems. For example, when the motion of a point is studied with respect to two coordinate systems, one of these systems is considered to be moving and the other is considered to be stationary, assuming that the fixed coordinate system is basic. Let the point move with respect to the moving coordinate system Oxyz, which in turn moves relative to the moving coordinate system. The motion of a point with respect to a moving coordinate system is called relative motion. The trajectory of a point with respect to its coordinate is called the relative trajectory. The velocity of a point in such motion is called the relative velocity, and its acceleration is called the relative acceleration. They are denoted as v_r and w_r, respectively.

The velocity and acceleration of a point at a given moment is the velocity and acceleration of the point of intersection of the moving coordinate system with the given point at the same time. They are denoted as v_e and w_e, respectively.

The motion of a point with respect to a fixed coordinate system is called absolute motion. The speed and acceleration of a point in absolute motion are called absolute velocity and absolute acceleration, respectively. They are denoted by and and wa.

Find the velocity of a point in complex motion

The relationship between the relative, repetitive, and absolute velocities of a point in complex motion is found using the velocity addition theorem. According to this theorem, the absolute velocity of a point is equal to the geometric sum of its relative and shear velocities.

$v_a = v_e + v_r$ (1)

Where and is the absolute velocity of the point, and ve is the transfer velocity of the point, and vr is the relative velocity of the point.

To find the relative velocity of a point, one must stop the thought motion, and the relative velocity of the point is found according to the rule of point kinematics.

To find the velocity of a point, one must stop the relative motion of the point and find the velocity of the point according to the rule of kinematics.

Projection (1) on the fixed coordinate axes:

$v_{ax} = v_{ex} + v_{rx}$, $v_{ay} = v_{ey} + v_{ry}$ (2)

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IJDPP
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then the absolute velocity modulus

$$v_a = |\bar{v}_a| = \sqrt{v_{ax}^2 + v_{ay}^2} \quad (3)$$

found from the formula. The direction of the absolute velocity is found from the directional cosines:

$$\cos(v_a, \wedge ox) = \frac{v_{ax}}{|\bar{v}_a|}; \qquad \cos(v_a \wedge oy) = \frac{v_{ay}}{|\bar{v}_a|} \quad (4)$$

It is recommended to follow the following procedure when solving the problem.

The movement must be divided into relative, implicit, and absolute constituents;

You must select a fixed and a moving coordinate system;

Find the relative velocity of the point by stopping the thought of moving;

It is necessary to find the velocity of the point by stopping the relative motion of the thought;

Applying the velocity addition theorem, we need to find the absolute velocity of the point we are looking for.

If the absolute velocity of a point is known, the abstraction or relative velocity can be found using the velocity addition theorem.

Find the accelerations of a point in complex motion

The theorem on adding accelerations is used to find the accelerations of a point in absolute, relative, relative motion, in other words, the Coriolis theorem is used.

$$w_a = w_e + w_r + w_k \quad (5)$$

where wa is the absolute acceleration of the point, we is the partial acceleration of the point, w_r is the relative acceleration of the point, and w_k is the Coriolis acceleration of the point.

To find the relative acceleration, we pause the motion and find the relative acceleration of the point using the rule of kinematics. To find the shear acceleration, we stop the relative motion of the point and find the shear acceleration of the point using the rule of kinematics. Coriolis acceleration is found from the following formula

$$w_k = 2\ w_e + v_r \ (6)$$

Where we is the angular velocity, the relative velocity of the point vr, and its modulus

$$w_k = 2 * w_e * v_r * \sin(w \wedge v_r). \ (7)$$

The direction of the Coriolis acceleration is found from the vector multiplication rule. If the displacement and relative motion of a point are curvilinear, formula (5) can be written as follows.

$$w_a = w_{en} + w_{et} + w_{rn} + w_{rt} + w_k \quad (8)$$

Here

w_{en} - copy normal acceleration,

w_{et} - portable acceleration,

ISSN 2792-3991 (online), Published under Volume: 1 Issue: 5 in October -2021
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w_{rn} - relative normal acceleration,

w_{rt} is the relative acceleration of the attempt.

The projection method is also used to apply the acceleration addition theorem.

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ISSN 2792-3991 (online), Published under Volume: 1 Issue: 5 in October -2021
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