Classical Mechanics

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Overview

D'Alembert's Principle

Newton's Second law of motion

$$F_i = \dot{p}_i \tag{1}$$

Total force F_i

$$F_i = F_i^e + f_i \tag{2}$$

where F_i^e is the applied external force and f_i is forces of constraints($f_i = 0$)
By the principle of virtual work

$$\sum F_i.\delta r_i = 0 \tag{3}$$

using eq(1)and eq(2) in (3)

$$\sum (F_i - \dot{p}_i).\delta r_i = 0 \tag{4}$$

or

$$\sum (F_i^e - \dot{p}_i).\delta r_i = 0 \tag{5}$$

This equation is known as D'Alembert's Principle

Statement and significance

The difference of applied force and inertial force for a dynamic system does no work.

Significance

- D'Alembert's principle introduce a new force, the force of inertia which is the negative of the product of mass and acceleration.
- If this force is added to the impressed force we have equilibrium - principle of virtual work is satisfied.
- gives complete solution of problems of mechanics
- can be applied equally to holonomic and nonholonomic systems

example

Consider 2 teams playing tug-of-war. A box of mass m is attached to a rope at two opposite places. Team A pulls the box with force F_A and Team B pulls it with force F_B.
The force of Team A is more, so the box is accelerated towards Team A.
Ans?