Theoretical Mechanics, Lab 4: KIN PLANE3 SPHER

Plane motion 3

Spherical motion

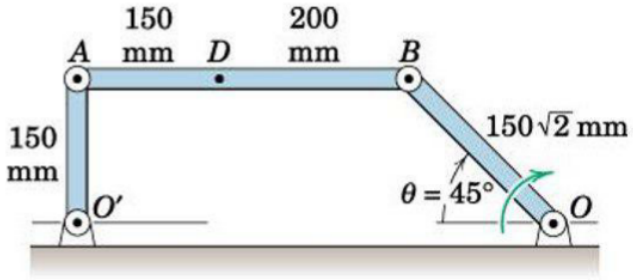
INNOPOLIS UNIVERSITY

Questions from the class

No questions this time

Task 1 (yours)

Arm *OB* of the linkage has a clockwise angular velocity of 10 rad/sec in the position shown where $\phi = 45°$. Determine the velocity of *A*, the velocity of *D*, and the angular velocity of link *AB* for the shown position.

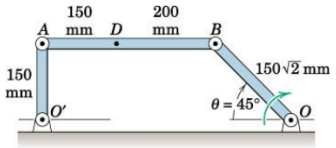


Task 1

Task 1 (yours): solution

Directions of vel of *A* and *B* are tangent to their circular paths @ fixed centers *O* and *O'*

- Intersection of the two perpendiculars to the vel from A and B → IC *C* for the link *AB*



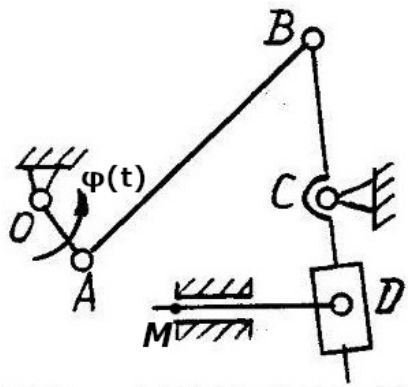
$AC = AB\tan 45 = 350\tan 45 = 350$ mm
$CD^2 = 350^2 + 150^2$ → $CD = 381$ mm
$CB^2 = 350^2 + 350^2$ → $CB = 350\sqrt{2}$ mm
Angular vel of *OB*: $\omega_{OB} = 10$ rad/s
$v_B = r\,\omega = 150\sqrt{2}\text{x}10 = 2121.3$ mm/s
Ang vel of *BC*: $\omega_{BC} = 2121.3/350\sqrt{2} = 4.29$ rad/s
BC is a line considered on the extended rigid body → $\omega_{BC} = \omega_{AC} = \omega_{DC} = \omega_{AB}$ (clockwise)

$v_A = r\,\omega = 350\text{x}4.29 = 1.5$ m/s
$v_D = r\,\omega = 381\text{x}4.29 = 1.632$ m/s
Directions of velocities are shown.

Task 2 (mine)

The task to find kinematics for the whole mechanism and velocities for *D*.

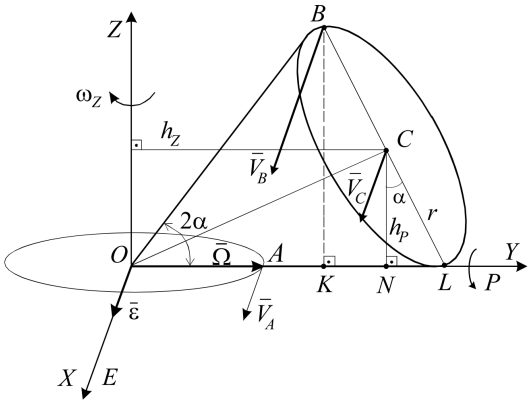
You know all lengths (*OA, AB, BC*), $\varphi(t)$.
Coordinates of all bases are known. The basis near to *M* point is horizontal respect to the ground.



Task 2

Task 3 (mine)

The cone (angle — 2α, $\alpha = 30°$, $r = 20$ — base) is rolling on a ground without friction. $\vec{V}_C = const = 60$.
It is needed to find Ω, ε, $\vec{V}_B$, $\vec{a}_B$.



Task 3

Task 3 (hints)

Угловая скорость и угловое ускорение

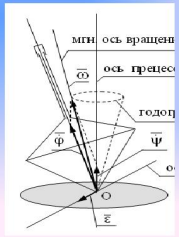
Вектор углового ускорения равен скорости движения конца вектора мгновенной угловой скорости по его годографу

$$\vec{\varepsilon} = \frac{d\vec{\Omega}}{dt}$$

Скорость точки конца вектора мгновенной угловой скорости $\vec{\Omega}$

$$\vec{V}_A = \frac{d\vec{\Omega}}{dt}$$

Следовательно: $\vec{\varepsilon} = \vec{V}_A$



При сферическом движении тела направления векторов $\vec{\Omega}$ и $\vec{\varepsilon}$ не совпадают.

г) угловое ускорение тела:

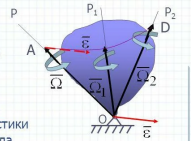
Векторная величина, характеризующая изменение с течением времени угловой скорости по модулю и по направлению – *мгновенное угловое ускорение тела*

$$\bar{\varepsilon} = d\bar{\Omega}/dt$$

AD – годограф вектора $\bar{\Omega}$

Направление ε совпадает с касательной к кривой AD в соответствующей точке

Векторы $\bar{\Omega}$ и $\bar{\varepsilon}$ - основные кинематические характеристики сферического движения тела



Task 4 (yours): M (rus) 19.9

321. A disk OA of radius $R=4\sqrt{3}$ cm rotating about a fixed point O rolls round a stationary cone of semi-angle 30° at a vertex (Fig. 239). Find the angular velocity of rotation of the disk about its axis of symmetry if the acceleration w_A of a point A on the disk has a constant magnitude and equals 48 cm/sec^2.

Ans. $\omega=2$ sec^{-1}.

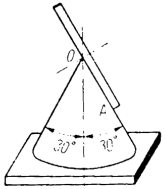


Fig. 239

Deserve “A” grade!

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Room 105 (Underground robotics lab)