K.N. Toosi University of Technology
Faculty of Mechanical Engineering

Issued on Monday Oct. 16th
(Mehr 24th 1396)
Due on Monday Oct. 23rd
(Aban 1st 1396)

Advanced Dynamics

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(Fall 2017)

Problem Set 1

1928
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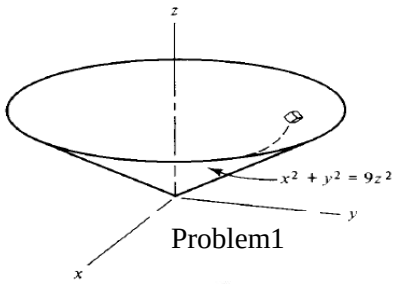
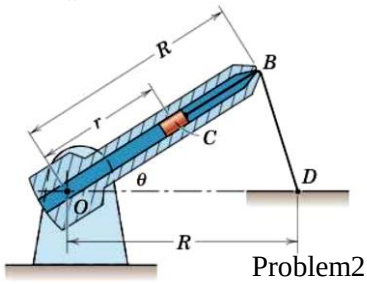
1- A right circular cone is defined by $x^2 + y^2 = 9z^2$, (x, y, and z have units of millimeters). The vertical position of a block sliding along the interior of such a cone is observed to be $z = 480 - 80t^2$, and $x = y^2/200$. Also, $y > 0$ throughout the motion. Determine the velocity and acceleration of the block when $t = 2$ s.



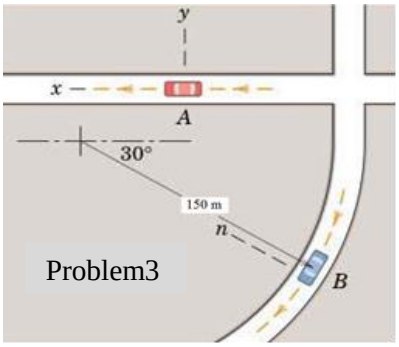
Problem1

2 - A) The slotted arm is pivoted at O and carries the slider C. The position of C in the slot is governed by the cord which is fastened at D and remains taut. The arm turns counterclockwise with a constant angular rate $\dot{\theta} = 4$rad/sec during an interval of its motion. The length DBC of the cord equals R, which makes r=0 when θ=0. Determine the magnitude a of the acceleration of the slider at the position for which θ=30°. The distance R is 375mm.
B) Repeat the question if the length OD equals 1.2R.



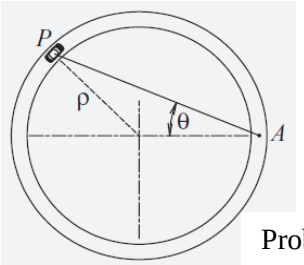
Problem2

3 - Car A is accelerating in the direction of its motion at the rate of 1.2 m/s^2. Car B is rounding a curve of 150m radius at a constant speed of 54km/h. Determine the velocity and acceleration which car B appears to have to an observer in car A if car A has reached a speed of 72km/h for the positions represented.



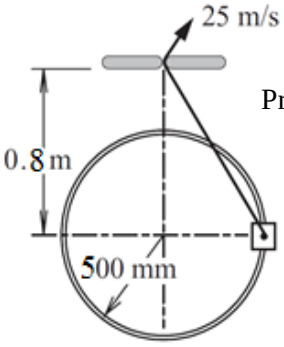
Problem3

4 - An observer at point A watches automobile P follow the circular track. The angle between the diametral line to the observer and the radial line to the automobile is a measured function of time, $\theta(t)$. Derive expressions for the velocity and acceleration in terms of the radius ρ of the track and θ.



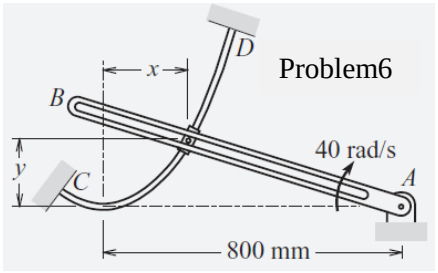
Problem4

5 - A cable that passes through a hole at point A is pulled inward at the constant rate of 25 m/s, thereby causing the 0.2-kg collar to move along the circular guide bar. The system is situated in the vertical plane. Determine the speed and the rate of change of the speed of the slider at the instant shown in the sketch.



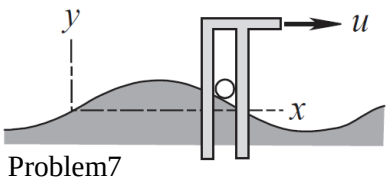
Problem5

6 - Arm AB rotates clockwise at the constant rate of 40 rad/s as it pushes the slider along guide CD, which is described by $y = x^2/200$ (x and y are in millimeters). Determine the velocity and acceleration of the slider when it is at the position x = 200 mm.



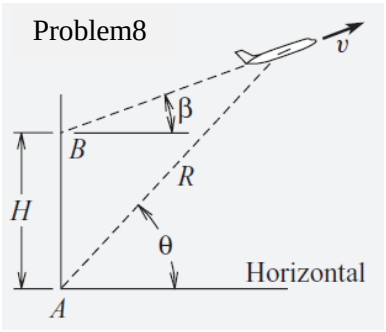
Problem6

7 - The diagram shows a small ball that is pushed in the vertical plane along a hill whose elevation is $y = H\sin(\pi x/L)$. The motion is actuated by an angle arm that translates horizontally at constant speed u. It may be assumed that the ball remains in contact with the hill. (a) Derive expressions for the velocity and acceleration of the ball as functions of its horizontal distance x from the origin. (b) Determine the maximum speed v of the ball and the value(s) of x at which it occurs. (c) Determine the maximum acceleration magnitude of the ball and the value(s) of x at which it occurs. (d) What is the largest value of u for which the ball will remain in contact with the hill when x = L/2? Friction is negligible, but gravity is not.

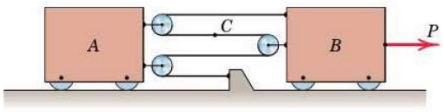


Problem7

8 - An airplane climbs at a constant speed v and constant climb angle β. The airplane is being tracked by a radar station at point A on the ground. Determine the radial velocity $\dot{R}$ and the angular velocity $\dot{\theta}$ as functions of the tracking angle θ.

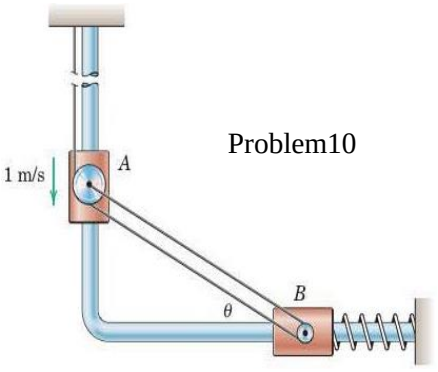


9 – Under the action of force P, the constant acceleration of block B is 3 m/s^2 to the right, determine the velocity of B relative to A, the acceleration of B relative to A, and the absolute velocity of point C of the cable.



Problem9

10 – Cylinder A has a constant downward speed of 1 m/sec. Compute the velocity of cylinder B for (a) $\theta = 45°$, (b) $\theta = 30°$, (c) $\theta = 15°$. The spring is in tension throughout the motion range of interest, and the pulleys are connected by the cable of fixed length.



Problem10