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

Issued on Monday Oct. 16th
(Mehr 24th 1396)
Due on Monday Oct. 30th
(Aban 8th 1396)

Advanced Dynamics

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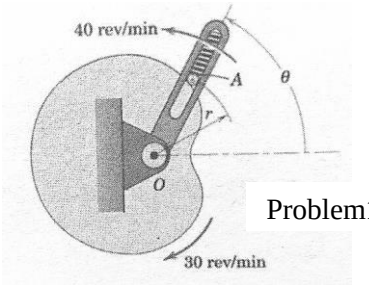
(Fall 2017)

Problem Set 2

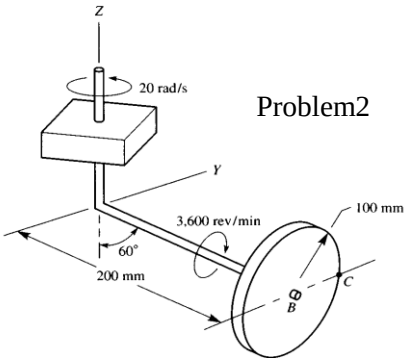
1928
K.N.T.U
Faculty of Mechanical Eng.

1 – The slotted arm rotates counterclockwise with a constant angular velocity of 40 rpm and the cam rotates clockwise with a constant angular velocity of 30 rpm. Due to the spring force, the ball A always remains on the cam surface whose shape is a cardioid described by the equation $r = b - c\cos\theta$. Determine the acceleration of ball A when the relative angle between the arm and the cam is 30°. For the cardioid, b=100mm and c=75mm.



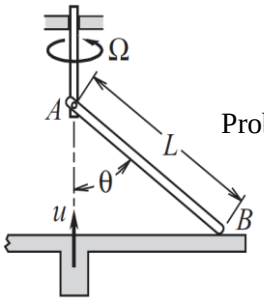
Problem1

2 – The disk is rotating about shaft AB at 3600 rev/min as the system rotates about the vertical axis at 20 rad/sec. Determine the angular velocity of the disk. Use this angular velocity to determine the approximate displacement of point C on the perimeter of the disk 2μs after the instant depicted in the sketch. Compare this result to the precise one obtained from the rotation transformation.



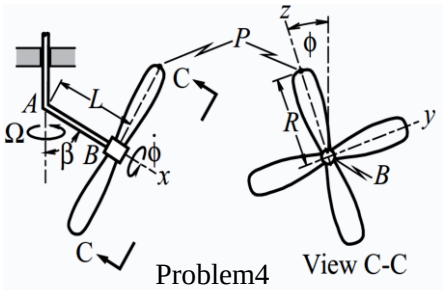
Problem2

3 - The vertical shaft rotates at the constant rate Ω, and the elevation of pin A is constant. End B of the bar slides over the base table, which translates upward at the constant speed u. Describe the velocity and acceleration of end B of the bar in terms of u, Ω, L, and θ .



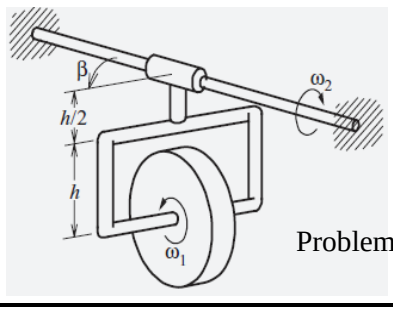
Problem3

4 - The cooling fan consists of a shaft that rotates about the vertical axis at angular speed Ω as the blades rotate around the shaft at angular rate $\dot{\varphi}$, where φ is the angle of rotation of one of the blades from the top-center position. Both rotation rates are constant. Derive expressions for the velocity and acceleration of the blade tip *P* in terms of components relative to the body-fixed *xyz* reference system.



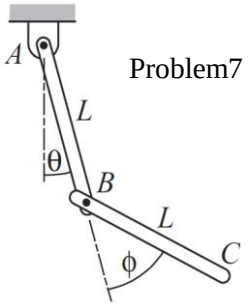
Problem4 View C-C

5 - The gyroscopic turn indicator consists of a flywheel that spins about its axis of symmetry at the constant rate ω_1 relative to the gimbal, as the assembly rotates about the fixed horizontal shaft at the variable rate ω_2. The angle β locating the plane of the gimbal relative to the horizontal shaft is an arbitrary function of time. Determine the angular acceleration of the flywheel at an arbitrary instant.



Problem5

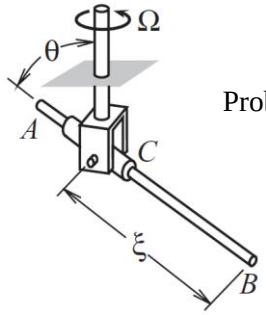
6 – Coordinate a is translated to coordinate b first with a 45°-rotation about a_1 axis and then a 30°-rotation about a'_2 axis (of intermediate coordinate a'). Construct the rotation matrix corresponding to this translation.



Problem7

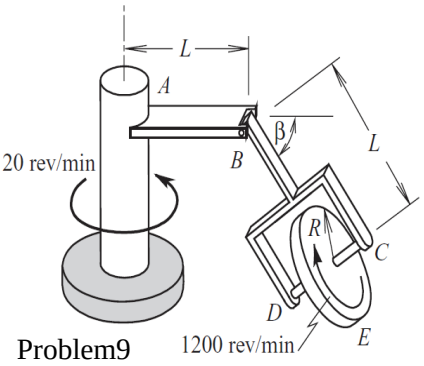
7 - A servomotor maintains the angle of bar BC relative to bar AB at $\phi = 2\theta$, where θ is the angle of inclination of bar AB. Determine the acceleration of end C corresponding to arbitrary values of θ, $\dot{\theta}$, and $\ddot{\theta}$.

8 – The vertical shaft rotates at the constant rate Ω. Collar C is attached to this shaft by a fork-and-clevis, so the angle of inclination θ of bar AB is an unknown time function. The bar is free to slide through the collar, so the distance ξ from the pivot point to end B is an arbitrary function of t. Derive expressions for the velocity and acceleration of point B in terms of ξ, θ, and their derivatives, as well as Ω.



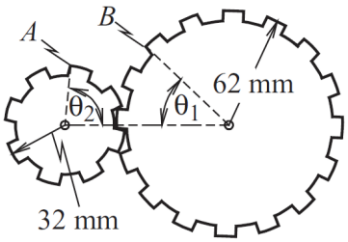
Problem8

9 - The disk spins about its axis CD at 1200 rev/min as the system rotates about the vertical axis at 20 rev/min. Both rates are constant. The angle of elevation of the arm supporting the disk is such that $\dot{\beta}$ = 10 rad/s and $\ddot{\beta}$ = −500 rad/s2 when β = 36.87°. Determine the velocity and acceleration of point E, which is the lowest point on the perimeter of the disk.



Problem9

10 - The larger gear rotates at half the angular speed of the smaller gear, which is rotating clockwise at a constant rate of 4800 rpm. Points A and B are corners of gear teeth that will mesh. At a certain instant $\theta_1 = 85^\circ$ and $\theta_2 = 42^\circ$. For this instant determine the velocity and acceleration of corner B with respect to corner A as seen from a reference frame that is attached to the smaller gear.



Problem10