**20-R-KM-DK-1**

A cat has found itself stuck on a platform controlled by a gear system. A bystander attempts to save it by turning handle A at a constant 5 rad/s2 in the clockwise direction.

The diameter of handle A and gear B is 0.3 m and 0.6 m respectively, and the two are rigidly attached. Gear C has a radius of 0.8 m while pulley D has a radius of 0.3 m. The cord in which the platform is connected to is wrapped around pulley D which is rigidly attached to gear C. Assume the system starts from rest.

a )Determine the velocity of the cat and the distance it travels in 5 seconds

b) If the cat gets motion sickness and cannot handle an acceleration of 3 m/s2 upwards, what is the maximum angular acceleration the bystander can turn the handle at? Are they currently over or under the limit?

**20-R-KM-DK-2**

In the following gear train, gear A is in contact with gear B. Gear B and gear C are rigidly attached, and gear C is also in contact with gear D. If gear A rotates at an angular velocity of 5 rad/s in the clockwise direction, what is the magnitude of the angular velocity of gear D?

**20-R-KM-DK-3**

A disk spins with an angular velocity of ***omega = 16/6 theta^2***. The disk starts at ***theta = 2 rad***. Determine the time needed for the angular velocity of the disk to reach ***omega = 600 rad/s***.

**20-R-KM-DK-4**

The flywheel rotates with an angular velocity of ***omega = 0.002theta^3* rad/s***.* Determine the angular acceleration when it has rotated ***5 revolutions***.

**20-R-KM-DK-5**

Stuck in quarantine, a retired engineer decides to jam out to his record player, only to find out that it's broken. He notices a pattern in which the record rotates, and hypothesizes that the angular distance the record travels can be described by the equation ***theta = 16 + 4t^2 + 3t^3***, where t is time in seconds. If he starts the player at t = 0s, determine the number of revolutions, the angular velocity, and the angular acceleration of the record at the instant when ***t = 30s***.

**20-R-KM-DK-6**

An engineering student is trying to create a new drivetrain system for his bike, consisting of a pulley system. Pulley A is connected to pulley B by a non-slip belt and pulley B is rigidly attached to pulley C. Pulley A rotates at an initial angular velocity of ***omega\_A = 3 rad/s*** , and has an angular acceleration of ***alpha\_A = 1.1theta rad/s^2***, where ***theta*** is in radians. Use this relationship to determine the magnitude of acceleration at point D when pulley A rotates ***4*** revolutions. The radii of each pulley is given to be ***r\_A = 10 cm, r\_B = 5 cm,*** and ***r\_C = 12 cm***, and point D is a distance ***r\_D = 8 cm*** from point B.

**20-R-KM-DK-7**

An engineer tries to be really funny and creates a prank punching machine. She wants to ensure the fist won't actually hurt anyone. She calculates that it will be perfectly safe as long as the boxing glove has a maximum velocity of ***v = 1 m/s***. What should the angular velocity of the worm gear (gear F) be to achieve this? Gear E is rigidly attached to gear D. For every 10 revolutions of gear F, gear E rotates once. Gears B, C, and D have radii ***r\_B = 3 cm, r\_C = 5 cm,*** and ***r\_D = 6 cm*** respectively.

**20-R-KM-DK-8**

A wheel traverses across ice and moves at a velocity of ***v\_A = 3 m/s*** to the right. Assume the wheel is slipping across the ground. If it rotates at an angular velocity of ***omega = 6 rad/s*** clockwise, what is the magnitude of the velocity at point B? The radius of the wheel is ***r = 0.3 m*** and B is at angle of 45 degrees with the vertical.

What would be the magnitude of the velocity at point C?

**20-R-KM-DK-9**

The following mechanism has links length ***l\_AD = 0.15 m, l\_BD = 0.3 m****,* ***l\_CD = 0.25 m***, and ***l\_DE = 0.2 m***. If the slider block A moves upward at a velocity of ***v\_A = 3.5 m/s***, determine the velocities of blocks B and C at the instant shown. The angle between link BD and the horizontal is given as ***theta\_BD = 35 degrees*** while the angle between link CD and the horizontal is ***theta\_CD = 30 degrees***.

**20-R-KM-DK-10**

A gear rolls on a fixed rack with an angular velocity of ***omega = 7 rad/s*** and an angular acceleration of ***alpha = 5.25 rad/s^2***. Determine the acceleration at point O, B, and A. The gear has a radius ***r = 0.4 m***.

**20-R-KM-DK-11**

Students are attempting to create a lift to raise their model car. The lift is assembled with two linkages, link AB and link BC, as seen in the picture shown. If the links have length ***r\_AB = 0.2 m*** and ***r\_BC = 0.4 m***, determine the velocity and acceleration of the lift at the instant where the magnitude of the angular velocity of AB is ***omega\_AB = 5 rad/s*** and the magnitude of the angular acceleration of AB is ***alpha\_AB = 7 rad/s^2***. Take the angles to be ***theta\_AB = 30 degree*** and ***phi\_BC = 20 degrees***.

**20-R-KM-DK-12**

A handyman has left a ladder leaning on a wall which begins to slip. At a given instant, the top of the ladder has an acceleration ***a\_B = 3m/s^2*** and a velocity of ***v\_B = 5 m/s***, both acting downward. Determine the magnitude of acceleration of the bottom of the ladder, A, and the magnitude of the ladder's angular acceleration at this instant. The length of the ladder is ***l = 10 m*** and forms an angle of ***theta = 30 degrees*** with the ground at A.

**20-R-KM-DK-13**

Several arms are linked to form the system shown. Link AB has a length of ***l\_AB = 0.5 m***, link CD has a length of ***l\_CD = 0.5 m***, and the distance from B to C is ***r\_C/B = -1 i + 1 j m***. If the angle between link AB is ***theta = 45 degrees***, determine the angular acceleration of link CD. The angular velocities of the links are given as ***omega\_AB = -3 k rad/s*** and ***omega\_BC = (3sqrt2)/4 k rad/s***, while the angular acceleration of AB is given as ***alpha\_AB = -5 k rad/s^2***.

**20-R-KM-DK-14**

A gear sits between two moving racks. If the top rack moves at a velocity of ***v\_A = 0.8 m/s*** to the left and the bottom rack moves at a velocity of ***v\_B = 0.45 m/s*** to the right, determine the velocity at the center of the gear, the angular velocity of the gear, and the distance to the ICZV from point B. The gear has a radius of ***r = 0.05 m***.

**20-R-KM-DK-15**

Bar AC rotates at ***omega\_AC = 2 rad/s*** with an angular acceleration of ***alpha\_AC = 1 rad/s^2*** . At that instant, it forms a ***phi = 55 degree*** angle with the vertical. If link BD makes a ***theta = 20 degrees*** angle with bar AC and has a length ***r\_BD = 0.8 m***, determine the magnitude of the angular velocity and the magnitude of the angular acceleration of link BD, as well as the magnitude of the relative acceleration of collar B. The link is connected to a collar which slides along bar AC. The distance to B from A is ***r\_AB = 1.1 m***.

**20-R-KM-DK-16**

Bar AC rotates at ***omega\_AC = 2 rad/s*** with an angular acceleration of ***alpha\_AC = 1 rad/s^2*** . At that instant, it forms a ***phi = 55 degree*** angle with the vertical. If link BD makes a ***theta = 20 degrees*** angle with bar AC and has a length ***r\_BD = 0.8 m***, determine the magnitude of the angular velocity and the magnitude of the angular acceleration of link BD, as well as the magnitude of the relative acceleration of collar B. The link is connected to a collar which slides along bar AC. The distance to B from A is ***r\_AB = 1.1 m***.

**20-R-KM-DK-17**

A linkage system consists of several arms, a collar, and a block. Arm AC has a total length ***r\_AC = 1 m*** and, in the instant shown, is at an angle of ***theta = 60 degrees*** with the horizontal. The collar sits on arm AC at a distance ***r\_AB = 0.6 m*** and is connected to arm BE, which sits vertically and has a length of ***r\_BE = 0.3 m***. If the collar slides up the arm at a constant rate with a relative velocity of ***v\_B/A\_rel = 0.5 m/s***, determine the angular velocity and angular acceleration of arm BE.

**20-R-KM-DK-18**

On a televised show, contestants run through an obstacle course. One obstacle is a turning platform which rotates at a constant ***omega = 4 rad/s*** clockwise. A contestant has successfully jumped onto one end and runs at a constant speed of ***v = 6.5 m/s*** relative to the platform. What is the magnitude of her velocity and acceleration when she reaches the other end of the platform? The platform has a length ***l = 2 m***.

**20-R-KM-DK-19**

A very funny engineer has attached her prank punching machine to a robotic arm. If the boxing glove moves at a maximum ***1 m/s*** constant velocity, relative to the link CD, what is the velocity and acceleration of the glove at the instant shown?

The lengths of the linkage arms are given as ***r\_AB = 0.3 m, r\_BC = 0.6 m***, and ***r\_CD = 0.4 m.***

The angles are given as ***theta = 30 degrees, phi = 50 degrees***, and ***gamma = 15 degrees***.

Arm BC is rotating at ***omega\_BC = 2 rad/s*** and ***alpha\_BC = 1 rad/s^2***, while arm CD is rotating at ***omega\_CD = -0.25 rad/s*** and ***alpha\_CD = 0.25 rad/s^2***. Arm AB is stationary throughout.

**20-R-KM-DK-20**

N/A

**20-R-KM-DK-21**

A linkage system consists of two arms and a collar. Arm AB has a length ***r\_AB = 0.5 m*** and, in the instant shown, is at an angle of ***theta = 45 degrees*** with the horizontal. The collar sits on arm CD and is at a distance ***r\_BC = 0.8 m*** from point C. If the collar slides up arm CD at a relative velocity of ***v\_B/C\_rel = 1.1 m/s*** , determine the angular velocity and angular acceleration of both arms.

**20-R-KM-DK-22**

Two boats are sailing on the high seas. At one instant, the boats are a distance ***d = 20 m*** apart and have parallel velocities. Boat A is heading straight while boat B sails in a circular path with radius ***r\_B = 10 m***. Boat A has a velocity ***v\_A = 30 m/s*** and an acceleration of ***a\_A = 15 m/s^2*** in the same direction. Boat B has a velocity ***v\_B = 5 m/s*** and a tangential acceleration of ***a\_B\_tangential = 20 m/s^2***. Determine the velocity and acceleration of boat A as seen from boat B.

**20-R-KM-DK-23**

A ***? m*** plank rests on a wedge that moves at a constant velocity of ***v = ? m/s*** to the right. If the plank makes an angle ***theta = ? degrees*** with the ground and rests on the wedge with an incline ***phi = ? degrees***, determine the angular velocity of the plank at this instant.

**20-R-KM-DK-24**

N/A

**20-R-KM-DK-25**

Determine the angular velocities and angular accelerations of links AB and BC if end D has a velocity of ***v = 3m/s*** to the right and an acceleration of ***a = 1 m/s^2*** to the left. Link AB and BC both have a length ***l = 0.5 m*** and the angle is given as ***theta = 60 degrees***.

**20-R-KM-DK-26**

Students are attempting to create a lift to raise their model car. The lift is assembled with two linkages, link AB and link BC, as seen in the picture shown. If the links have length ***l\_AB = 0.2 m*** and ***l\_BC = 0.4 m***, determine the velocity and acceleration of the lift at the instant where the angular velocity of AB is ***omega\_AB = -5 rad/s*** and the angular acceleration of AB is ***alpha\_AB = -7 rad/s^2***. Take the angles to be ***theta = 30 degrees*** and ***phi = 20 degrees***. Use absolute motion analysis to determine your answers.

**20-R-KM-DK-27**

Students have created a linkage system to test the conversion of rotational motion into translational motion. The linkage system consists of a disk, two arms, and a sliding block limited to horizontal movement. If the disk and block are connected by an arm of length ***l = 1.5 m*** at an angle of ***theta = 30 degrees***, determine the magnitude of the angular velocity of the arm BC, as well as the magnitude of the velocity of the disk at point B. The sliding block moves at a velocity of ***v = 3 m/s*** to the left and the disk has a radius ***r = 0.8 m***.

**20-R-KM-DK-28**

A student has set up a mechanism to catch fish. At a certain instant, the reel is rotating with an angular velocity of ***omega = 3 rad/s*** and has an angular acceleration of ***alpha = 0.15 rad/s^2***. Determine the velocity and acceleration of the fish at this instant. The disk has radius ***r\_AB = 1.5 m***, and AB is currently at an angle of ***30 degrees*** with the horizontal. The distance from A to C is ***r\_AC = 2.5 m***.

**20-R-KM-DK-29**

The end A of a bar is constrained by a horizontal slot. At one instant, the bar is moving with a velocity ***v = 0.185 m/s*** and acceleration ***a = 0.1 m/s^2*** to the right. If semicircle B has a radius ***r\_B = 0.5 m***, determine the angular velocity and angular acceleration of the bar at this instant. The distance from end A to the center of the semicircle is ***r\_AB = 0.8 m***.