Panel 1

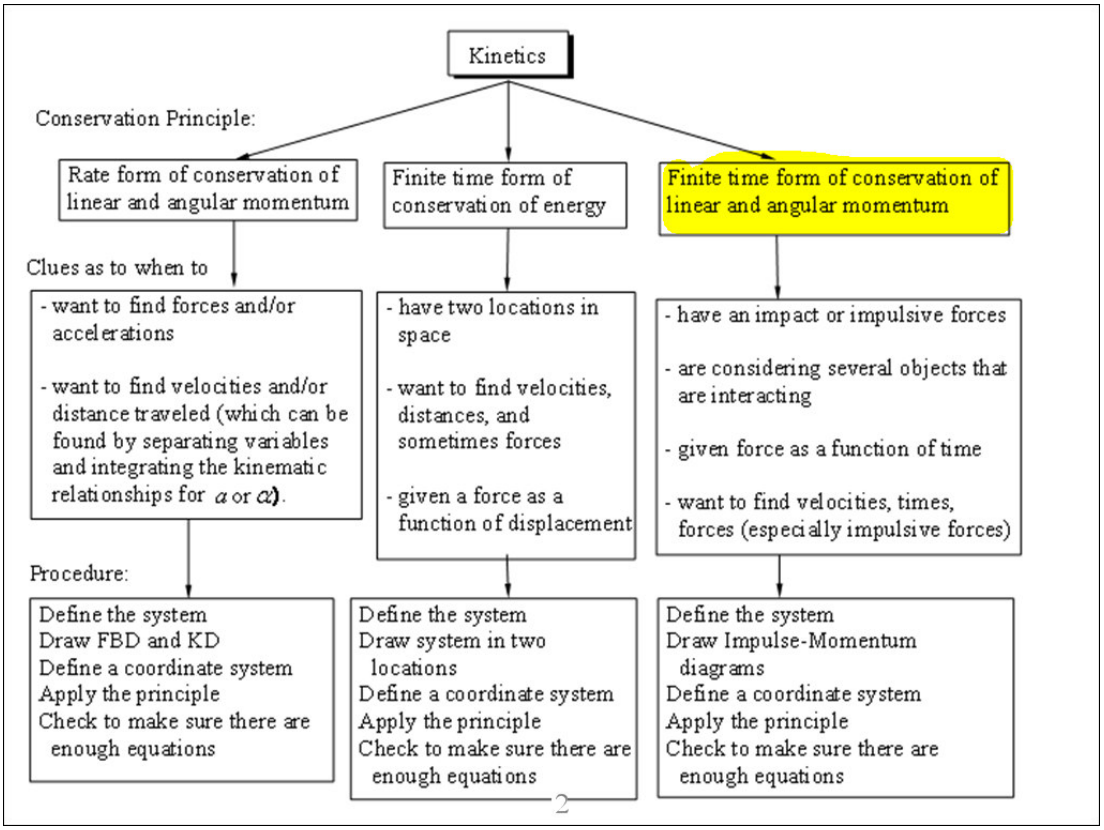
ES204 Mechanical Systems

Non-Impact Finite Momentum
Lecture 20

Dr. Fisher

1

Panel 2



2

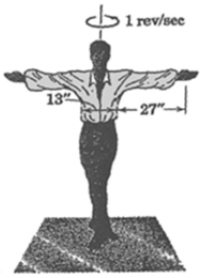
Panel 3

Rigid Body Motion Matrix

	Kinematics	CoLM CoAM Rate	Energy	CoLM CoAM Finite
Translation	Le10	Le10	✓	✓
Fixed Axis Rotation	Le11	Le12	Le12	Le13
General Plane Motion	Le14 Le15		Le16	Le19 Le20

3

Panel 4



The 165-lb ice skater with arms extended horizontally spins about a vertical axis with a rotational speed of 1 rev/sec. Estimate his rotational speed if he fully retracts his arms, bringing his hands very close to the centerline of his body.

As a reasonable approximation, model the extended arms as uniform slender rods, each of which is 27" long and weighs 15 lbs. Model the torso as a solid 135-lb cylinder 13" in diameter. Treat the man with arms retracted as a solid 165-lb cylinder of 13" diameter. Neglect friction at the skate-ice interface.

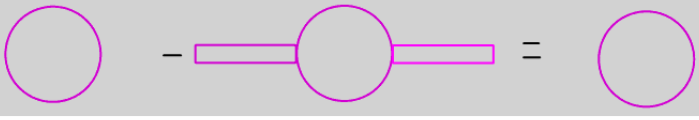
4

Panel 5

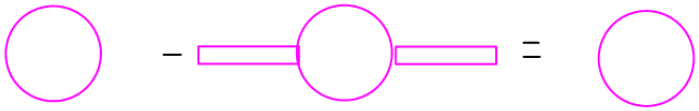
The 165-lb ice skater with arms extended horizontally spins about a vertical axis with a rotational speed of 1 rev/sec. Estimate his rotational speed if he fully retracts his arms, bringing his hands very close to the centerline of his body.

As a reasonable approximation, model the extended arms as uniform slender rods, each of which is 27" long and weighs 15 lbs. Model the torso as a solid 135-lb cylinder 13" in diameter. Treat the man with arms retracted as a solid 165-lb cylinder of 13" diameter. Neglect friction at the skate-ice interface.

After Arms in — Before Arms extended = Impulses During



After Arms in — Before Arms extended = Impulses During



5

Panel 6

After Arms in — Before Arms extended = Impulses During

Write CoAM Finite eq

$I_m =$

$I_T =$

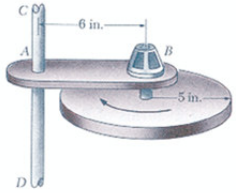
$I_a =$

Eq	Unk
1	v
2	ω

6

Panel 7

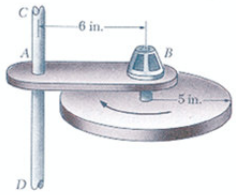
A 10-lb disk is attached to the shaft of a motor mounted on arm AB which is free to rotate about the vertical axle CD. The arm-and-motor unit has a moment of inertia of 0.032 lb ft s^2 with respect to the axle CD, and the normal operating speed of the motor is 360 rpm. Knowing that the system is initially at rest, determine the angular velocities of the arm and of the disk when the motor reaches a speed of 360 rpm.
(*taken from Vector Mechanics for Engineers, 5th Edition by Beer & Johnston*)



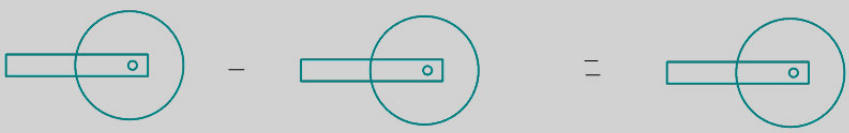
7

Panel 8

A 10-lb disk is attached to the shaft of a motor mounted on arm AB which is free to rotate about the vertical axle CD. The arm-and-motor unit has a moment of inertia of 0.032 lb ft s^2 with respect to the axle CD, and the normal operating speed of the motor is 360 rpm. Knowing that the system is initially at rest, determine the angular velocities of the arm and of the disk when the motor reaches a speed of 360 rpm.
(*taken from Vector Mechanics for Engineers, 5th Edition by Beer & Johnston*)



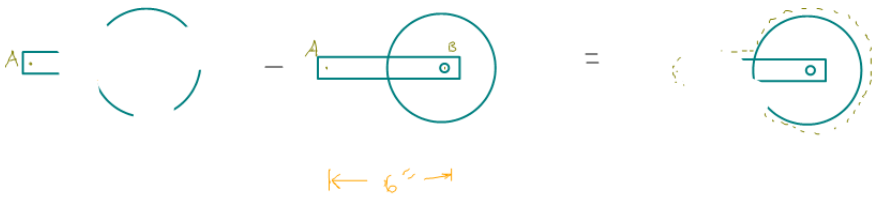
Momentum After - Momentum Before = Impulses During



8

Panel 9

Momentum After - Momentum Before = Impulses During



Write CoAM Finite equation

9

Panel 10

A 10-lb disk is attached to the shaft of a motor mounted on arm AB which is free to rotate about the vertical axle CD. The arm-and-motor unit has a moment of inertia of 0.032 lb ft s^2 with respect to the axle CD, and the normal operating speed of the motor is 360 rpm. Knowing that the system is initially at rest, determine the angular velocities of the arm and of the disk when the motor reaches a speed of 360 rpm.
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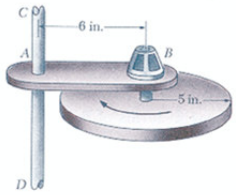

Still need I_{disc} & I_r equations

$I_{r/o} = 0.032$ lb ft s^2

Write I_d equation (ω)

10

Panel 11

A 10-lb disk is attached to the shaft of a motor mounted on arm AB which is free to rotate about the vertical axle CD. The arm-and-motor unit has a moment of inertia of 0.032 lb ft s^2 with respect to the axle CD, and the normal operating speed of the motor is 360 rpm. Knowing that the system is initially at rest, determine the angular velocities of the arm and of the disk when the motor reaches a speed of 360 rpm.
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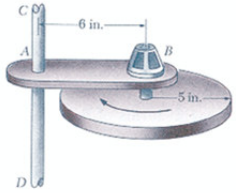

Use Relative Motion to relate omegas

2π

11

Panel 12

A 10-lb disk is attached to the shaft of a motor mounted on arm AB which is free to rotate about the vertical axle CD. The arm-and-motor unit has a moment of inertia of 0.032 lb ft s^2 with respect to the axle CD, and the normal operating speed of the motor is 360 rpm. Knowing that the system is initially at rest, determine the angular velocities of the arm and of the disk when the motor reaches a speed of 360 rpm.
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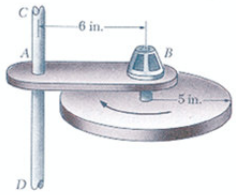

Eq	Unk	
1	I_r	
2	ω_r	V_r
3	I_d	
4	ω_d	V_d
5		
6		

$\vec{\omega}_r =$ $\hat{k}$ rpm $\vec{\omega}_D =$ $\hat{k}$ rpm

12