Lab 6A

SolidWorks Motion Study

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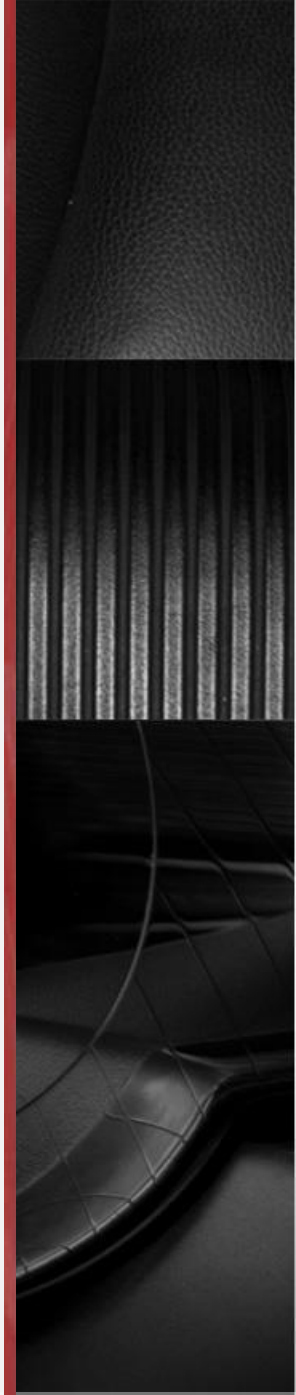
Summer 2020



Lab-6A Assignment

This Lab consists of three Motion Studies.

1. **Valve-Cam SOLIDWORKS Tutorial**
2. **Four Bar Linkage**
3. **Compound Gears**

Document your work as instructed and upload a short report by the next Lab Session (Friday).

Motion Study

- SolidWorks Motion is an add-in module, which allows you to evaluate and analyze your design in motion prior to moving on to the prototyping stage.

- It allows you to determine specific aspects related to design such as power consumption of motors, sizes of springs, dampers and motors, and the forces related to surfaces in contact.

- SolidWorks Motion Analysis simulate:
  - **Kinematic**, which refers to the study of the motion of a rigid body **without considering the forces** that result in the motion of the body – select "***Basic Motion***" in SW.
  - **Dynamic**, which refers to the study of the motion of a rigid body as a result of the **applied external** forces on the body – select "***Motion Analysis***" in SW.

Motion Study

SolidWorks Motion Analysis Outputs include:

- Displacements
- Reaction Forces
- Accelerations
- Motor Torque

SW Motion Analysis Assumptions:

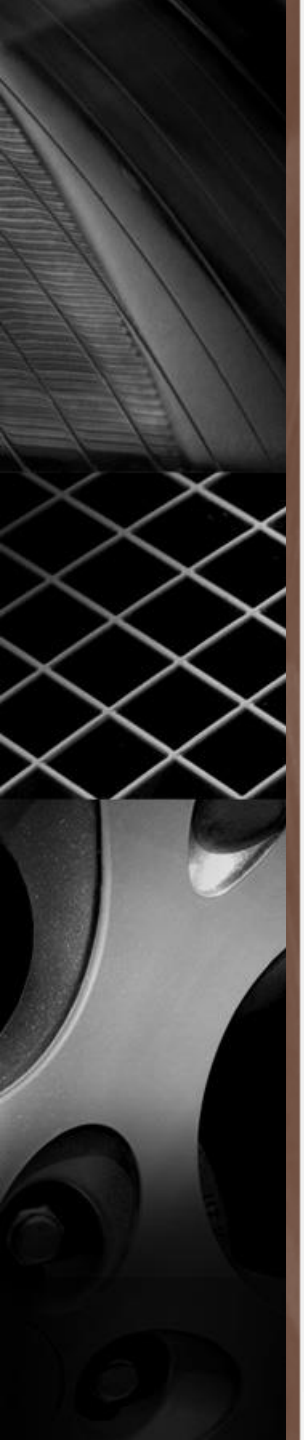
- Rigid Bodies
- Materials have been assigned to all parts
- Mates are accurate

Before you begin:

- Prior to using Motion Study you must define clearly how the assembled parts are expected to move.
- It is important to assemble the parts using particular mates that allow for specific kinds of motion of certain parts, such as **gear mates, hinge mates, cam mates, pulley mates,...**.
- Once the parts have been assembled and mated accurately, you are ready to begin motion analysis.
- Make sure the "Motion Study" module is added - to add the Motion module, click

Tools » Add-ins » SolidWorks Motion.

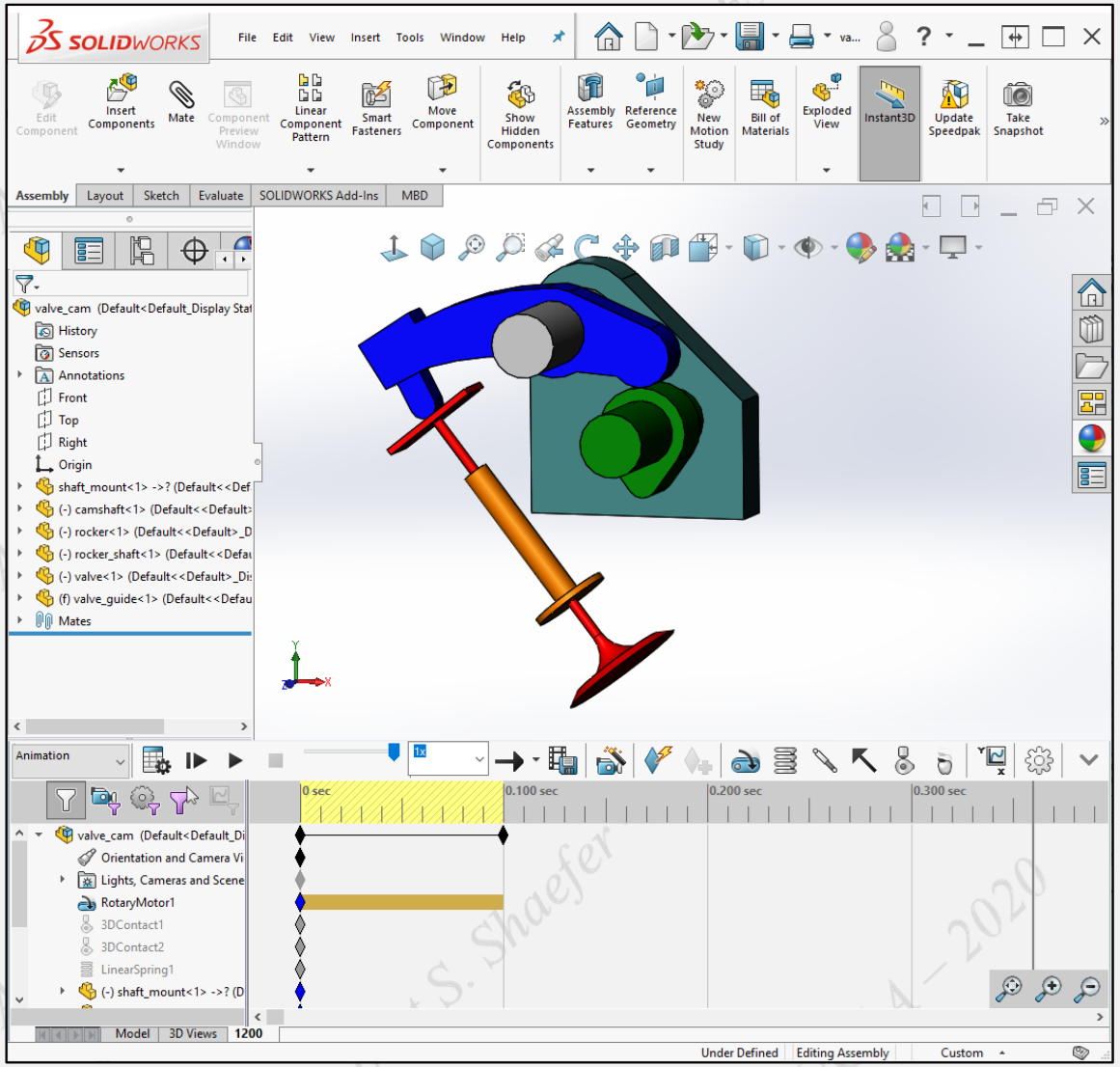
Checking the box on the left opens the SolidWorks Motion module for your current session, checking the box on the right however opens SolidWorks motion permanently for every session you begin.

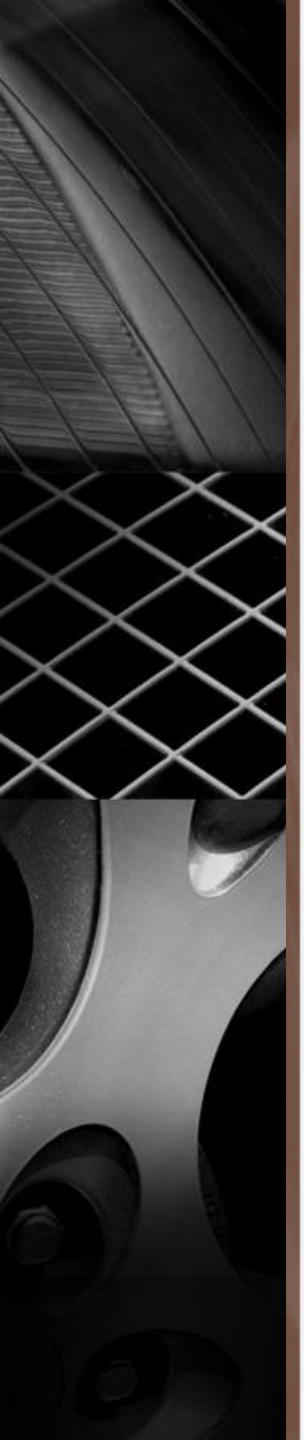


P1: Motion Study Tutorial

Motion Study Tutorial

- Open SW Tutorials:
  "Help → SOLIDWORKS Tutorial → ALL SOLIDWORKS Tutorials→ SOLIDWORKS Motion"
- Work through the Motion Study tutorial
  NOTE: try not to skip steps of the tutorial.
- Your Results:
  If your resulting contact forces are not the same as listed in the tutorial, double check that you followed instructions correctly, only then move on to the next problem.





P2. 4-Bar Linkage

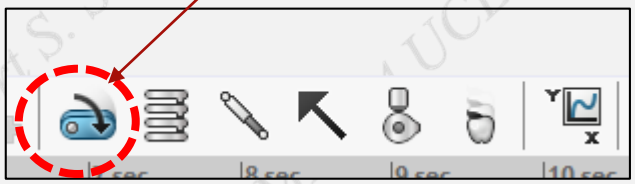
50 points (Document Your Work and Results)

Motion Study: 4 Bar Linkage

Problem 2.1

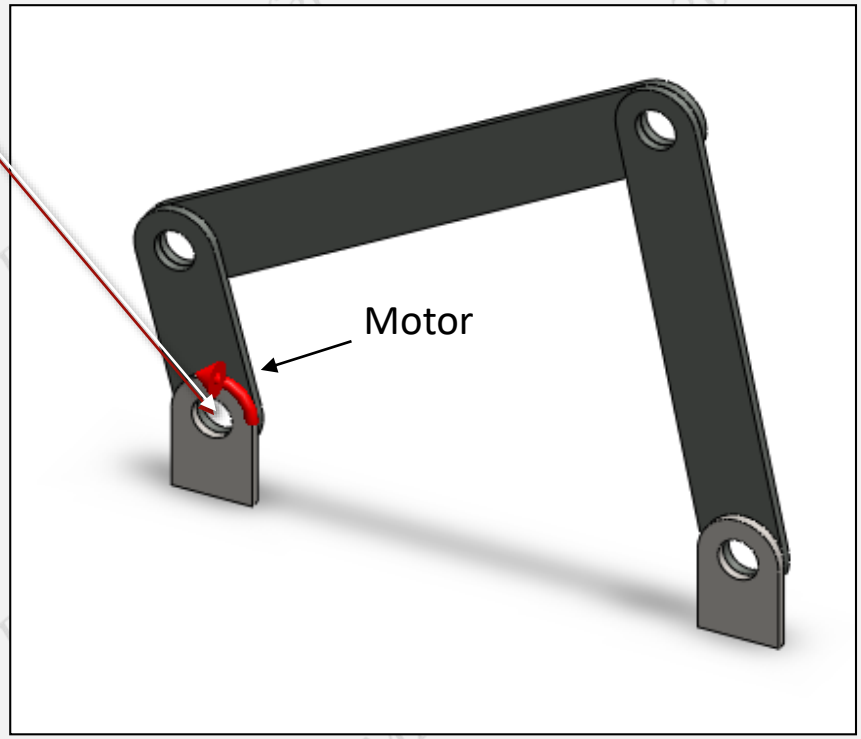
Download the 4 Bar Linkage assembly (CCLE) and determine the *required motor torque* for the following specifications:

- All links are made of pure **Pb** (lead)
- Apply a motor with constant speed of **100 RPM** (to the inner circular face of the **link**)



- Solve and run for **1 second**
- Save the ***Motor Torque**** plot (maximum torque should be around 400 N-mm)

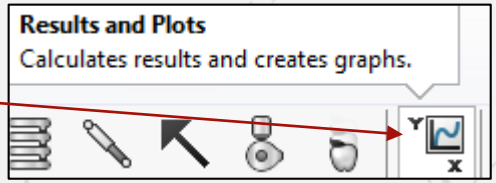
*Next slide



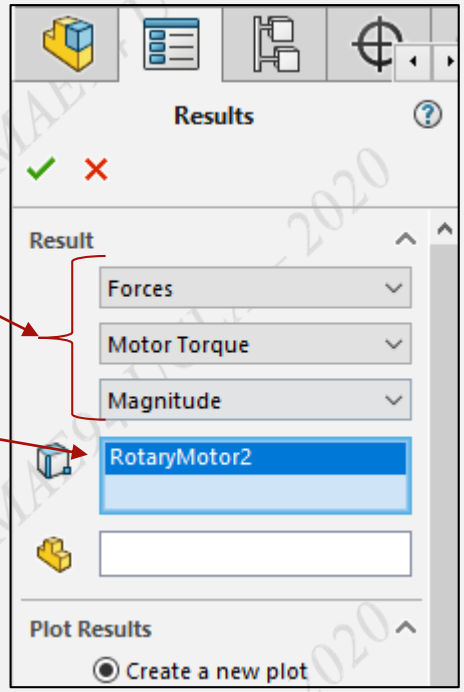
Motion Study: 4 Bar Linkage

To display the Motor Torque Plot:

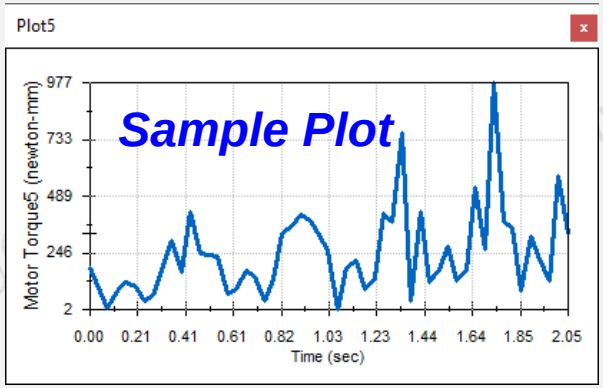
1. Click on “Results and Plots”



2. Chose *Forces* → *Motor Torque* → *Magnitude*



3. Click on “*RotaryMotor1*” in the Motion Analysis Feature Manager
4. Click OK and the ***Motor Torque*** Plot appears:



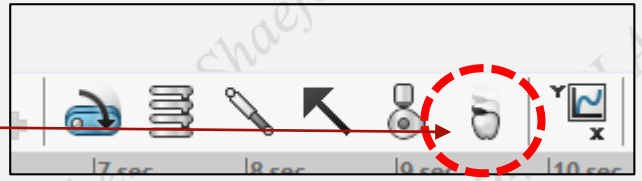
5. Save the Plot!

Motion Study: 4 Bar Linkage

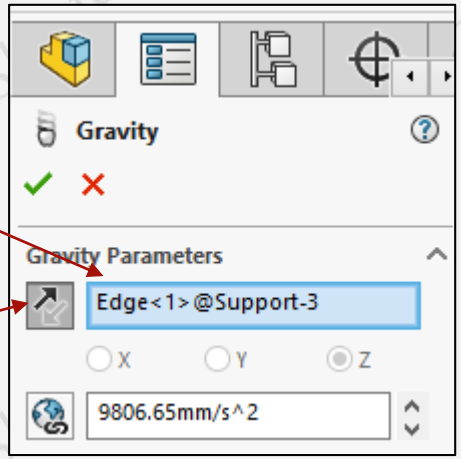
Problem 2.2

Now add Gravity:

- Click on the “gravity” icon.



- Choose an edge on the support plate to select the direction of gravity.
- Check the direction of gravity, (see small green arrow lower right corner of graphics area):
  Click here to flip direction.



- Click OK and run the analysis, a new Motor Torque plot is produced.
- Save the Motor Torque Plot!

Motion Study: 4 Bar Linkage

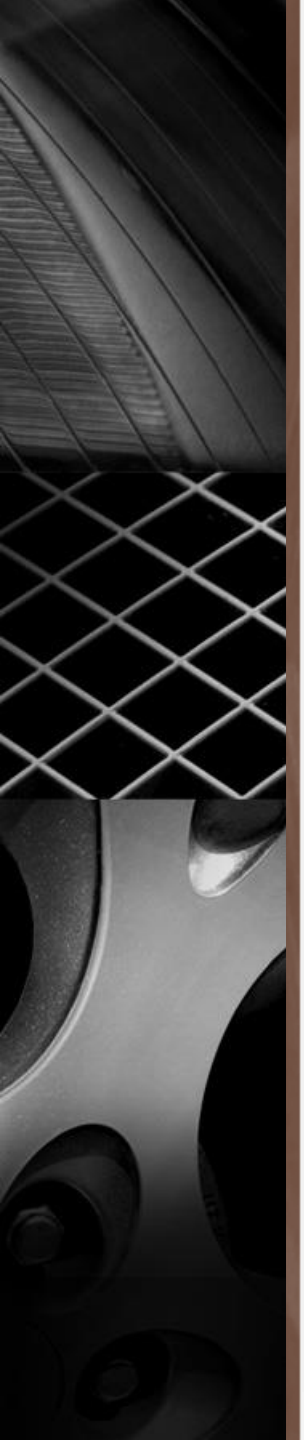
Deliverables:

P1: SW Tutorial (no deliverable)

P2.1: Motor Torque plot (no gravity).
P2.2: Motor Torque plot with gravity.

Save the motor torque plots to be presented in a PDF file with a cover sheet, figure numbers, and figure captions – please ***write the maximum torque*** value in the figure captions.

LastName_MotionStudy.pdf.



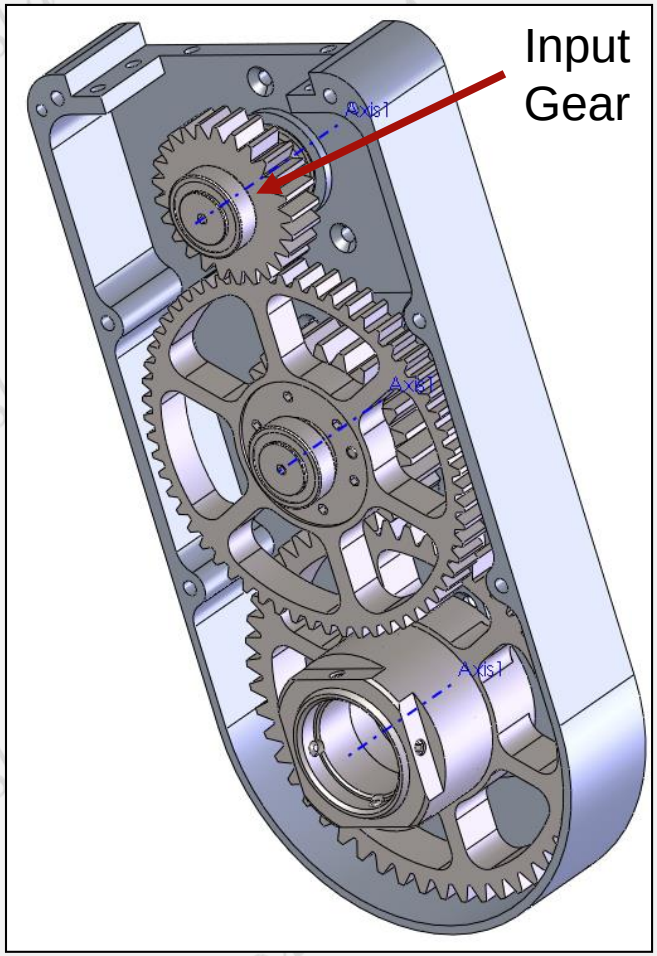
3. Compound Gear

50 points (Document Your Work and Results)

Motion Study: Compound Gear

Download the Compound Gear (CCLE):

Ignore any error regarding missing components (check the “suppress all missing components” rebuild and continue).



Problem 3:

- **Determine the required motor torque to drive the compound gear given the following specifications:**
  - Housing material: Aluminum 2014
  - Gears are made of 4130 Steel (annealed)
  - Make sure the units are set to MMGS

Motion Study: Compound Gears

- The goal is to estimate the ***required input motor torque*** for the following cases:

P3.1: Apply a rotary motor with a constant speed of **10 RPM** to the input gear (small gear).

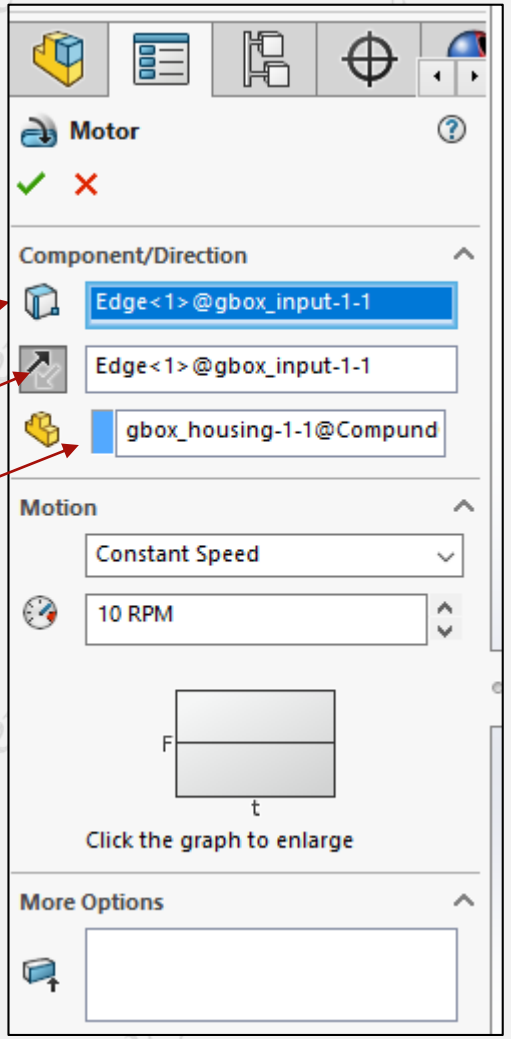
STEPS:

Choose any circular edge on the input gear.

The motor should rotate clockwise (toggle motor direction by clicking here):

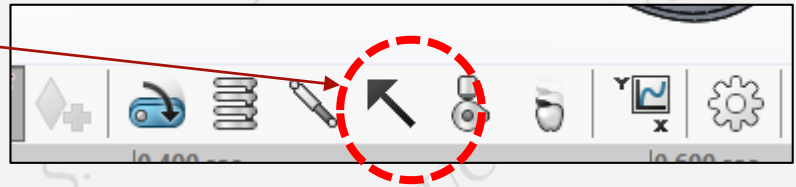
Select the gear box housing

Run the analysis for at least 3-sec and save the Motor Torque Plot



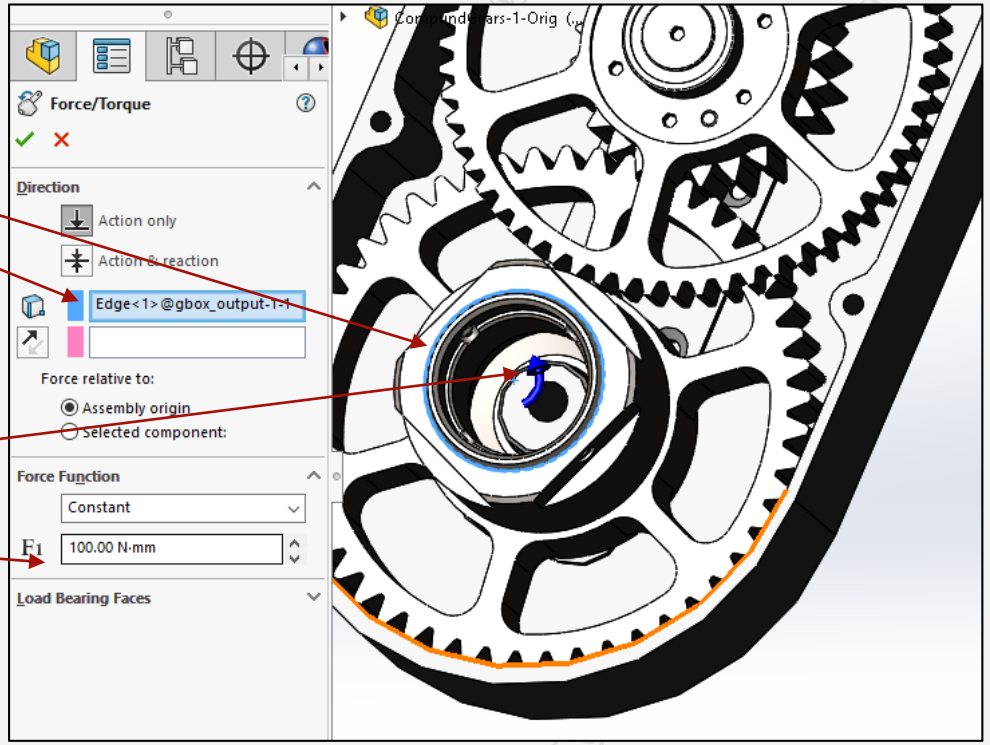
Motion Study: Compound Gears

P3.2: Click the thick arrow to add a counteracting torque to the driven gear (largest).



Select the any circular edge of the driven gear.

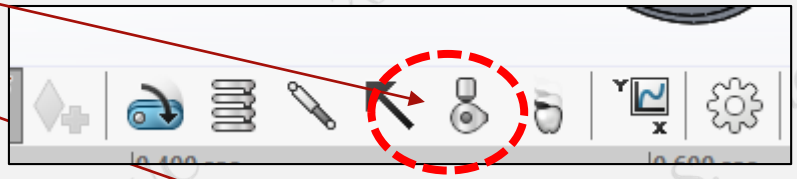
Apply a counter-clockwise torque of 100 N-mm :



Run the analysis and save the Motor Torque Plot.

Motion Study: Compound Gears

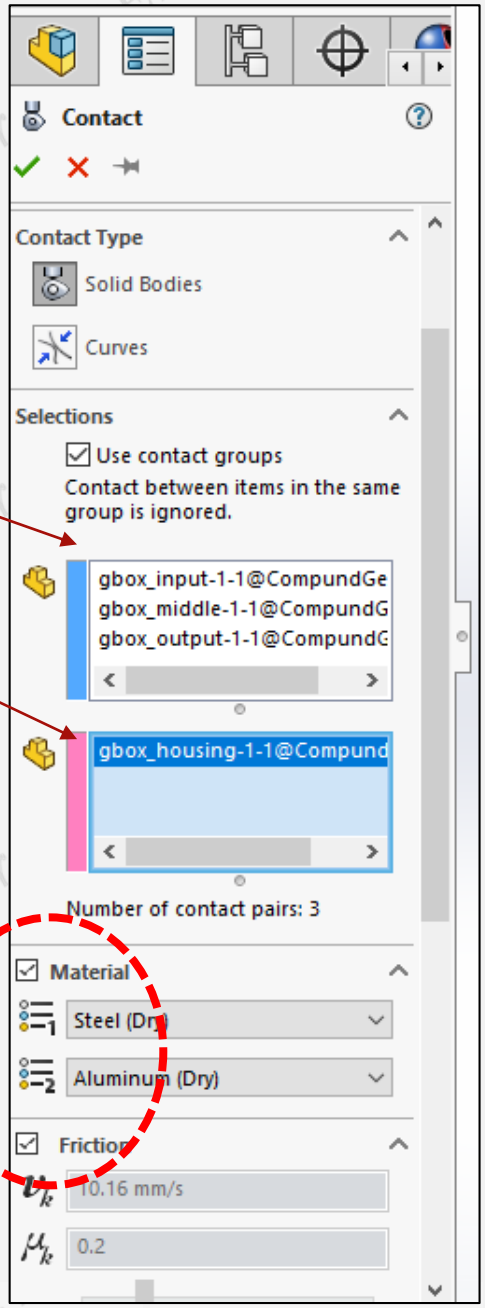
P3.3: Add **friction** between the gears and the housing: click and select all three gears and the housing!



- Click on “Material” and select “Steel (Dry)” for gears and “Aluminum(Dry)” for the housing ; make sure “Friction” is checked.
- Run the analysis and save the Motor Torque Plot

P3.4: Repeat the analysis, but change Materials to “Steel (Greasy)” and “Al(Greasy)”

- Run the analysis and save the Motor Torque Plot



Motion Study: Compound Gear

Deliverables:

Please combine the four ***Compound Gears*** and the ***4 Bar Linkage*** motor torque plots into a single PDF file.

Add figure numbers and write the maximum torque values of each plot in the figure caption.

Upload a single PDF file: *LastName_MotionStudy.pdf.*