Halogen Lightbulb Cam Project (ME 3202 Final Project)

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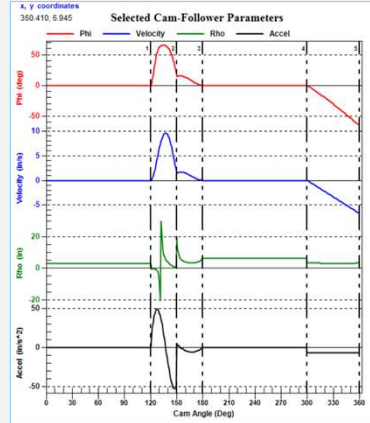
Project / Problem Description

This project designs a cam–follower mechanism for automating halogen headlight bulb assembly. The system precisely guides a gripper arm that picks up a fragile filament, inserts it into a socket, holds it steady for soldering, and returns to its start position.
Because the filament is easily damaged, the cam must minimize shock by ensuring zero velocity at critical positions, limiting insertion speed, and providing a stable dwell period for soldering.
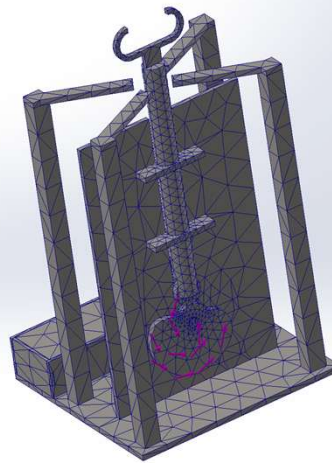
Design Constraints / Task Specifications

✓Velocity should stay below 10 in/s during grip, insertion, and seat to prevent filament damage.
✓A long dwell period is required to keep the filament stable during soldering.
✓The pressure angle must remain ≤ 30° throughout, and base circle radius ≥ 3 in to avoid undercutting.
✓Cycloidal and modified-sine motion laws are used to ensure smooth acceleration and low jerk.
✓The design achieves a total lift of 3.5 in, divided across the rise segments.
✓The design produces a maximum von Mises stress of 35 MPa, giving a safety factor of 2 based on a conservative assumed ultimate tensile strength for 1000-series aluminum (ASM International, 2001)
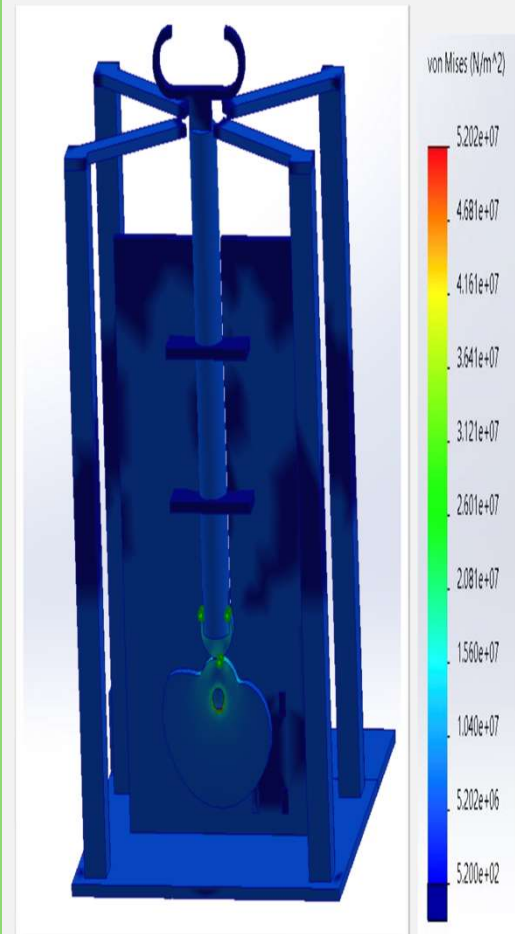
SVAJ Diagram and Cam

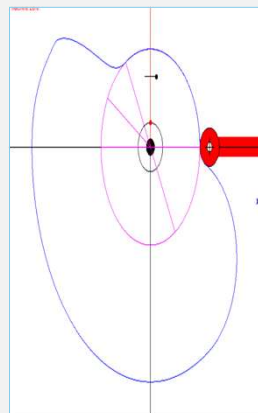## Mesh Analysis (Safety Factor)

FEA Von Mises Stress

Problem Solution

✓The cam profile uses five motion segments across 360° to guide the follower smoothly through the filament-insertion process. A five-segment design was chosen to avoid overlap or undefined velocities during the critical gripping and seating phases while maintaining continuous, controlled motion.

Seg	Beta	Start	End	Motion	Start	End
1	120	0	120	Dwell	0.000	0.000
2	30	120	150	Poly	0.000	3.000
3	30	150	180	Poly	3.000	3.500
4	120	180	300	Dwell	3.500	3.500
5	60	360	360	Poly	3.500	0.000

Dynacam Cam Profile

Results

✓Velocity 9in/s at points B and 1.5in/s C.
Maximum pressure angle = 27° (< 30°) .
✓No undercutting observed at minimum radius of curvature .
✓Smooth S–V–A–J profiles achieved.
✓Total lift = 3.5 in achieved precisely .
✓Design meets all functional and mechanical constraints
✓There was a maximum von Mise Stress of 52.02 MPA which correlates with a safety factor of 1.35
✓The maximum acceleration throughout the motion is 52.453 in./s²