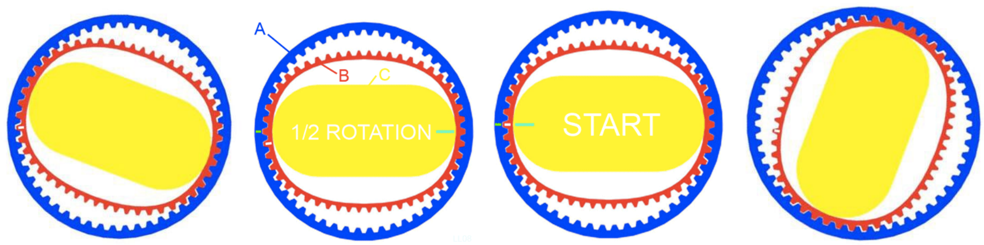
ME58120320 HW#1

Due: July 4th (Thursday) at 8:00 AM before lecture

Ch 1: Introduction

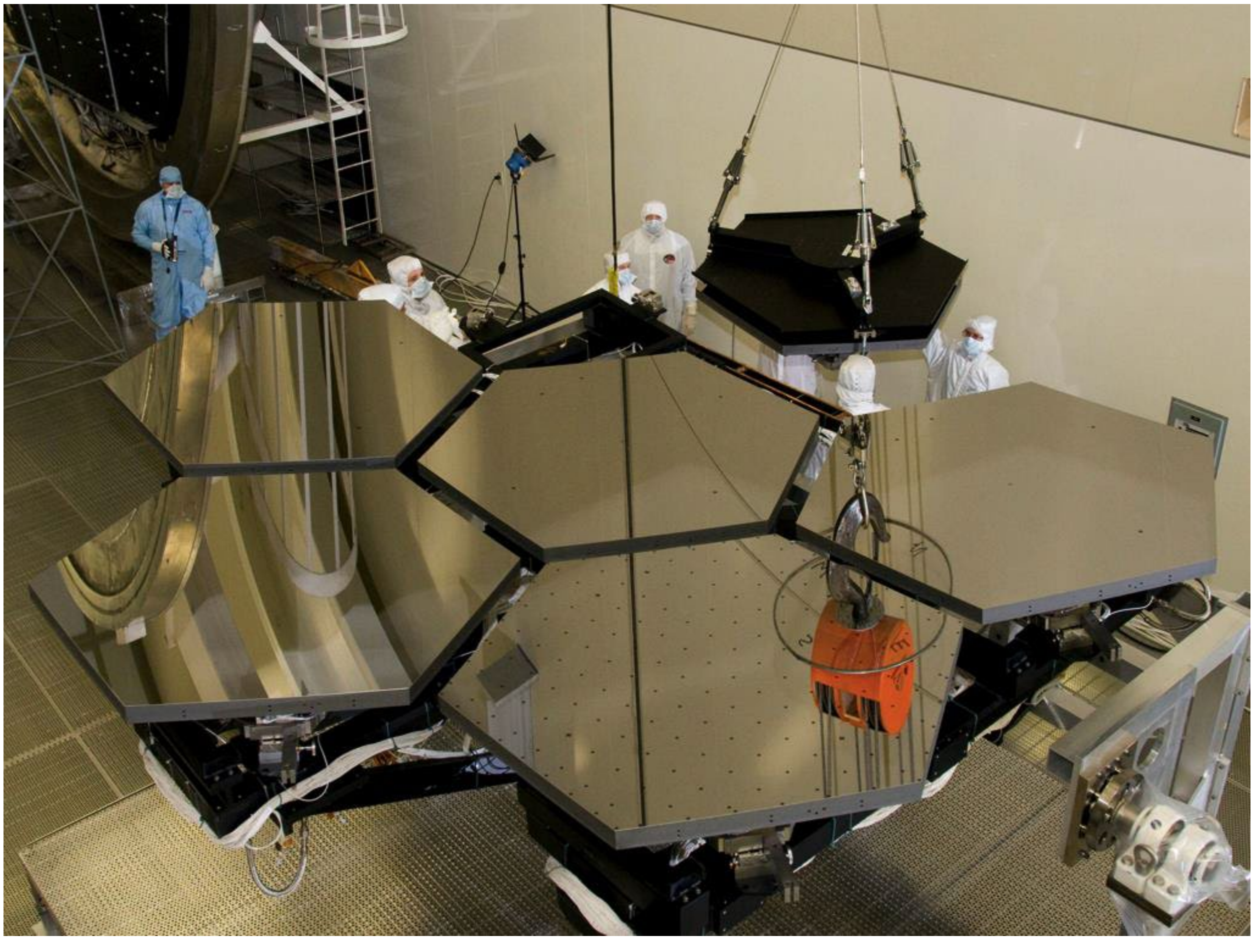
1. Machining process for the three key components of the harmonic drive, which is used extensively in robotics and machines. Three key parts of the harmonic drive are – Part A: circular spline (fixed), Part B: flex spline (attached to output shaft, not shown), and Part C: wave generator (attached to input shaft, not shown). Describe the machine processes to create the **2D features shown in the drawing below for Parts A, B and C**. Note: Do NOT discuss the machining of 3D real parts in the class video. The design and manufacturing of the durable harmonic drive are challenging and only a few companies in the world can make this product. (15 points)



2. What are the machining processes to produce the centrifugal compressor impeller/wheel of a turbocharger? What is the design feature to allow high material removal rate to create the propeller blade? (5 points)

Ch 2: Singe point cutting

1. These telescope mirrors are not flat. How to create the precise shape on these mirror surfaces (NOT the hexagon shape)? (4 points)

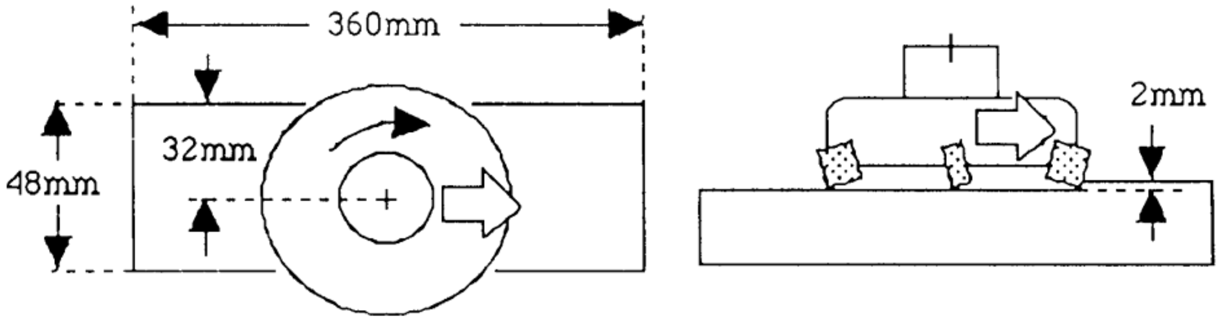


3. A HSS turning bit with a major cutting edge angle of 60° and a minor cutting edge angle of 10° is used on a 1 kW lathe to turn a 50 mm diameter cast iron bar. The maximum surface cutting speed that the tool can tolerate without overheating is 500 m/min. If a 100 mm long pass is to be completed within 1 minute, what is the minimum *Ra* (in mm) achievable (9 points), and what is the largest (radial) depth of cut that can be executed (9 points)? Do not use safety factors.

4. An AISI 1020 carbon steel cylinder of 30 mm diameter is turned on a lathe to reduce its diameter by 2 mm. The length to be machined on the cylinder is 60 mm. The lathe has 1.5 kW available at the spindle and the HSS cutter is assumed to be perfectly sharp and has a major cutting edge angle of 75º and a minor cutting edge angle of 5º. Suppose the operation is to be done in one pass with a smooth surface finish of *Ra* less than 10 µm is desired. Use a safety factor of 2.5 on the desirable *Ra* and on the available machine power. Find:
(1) the spindle speed (in rpm) (9 points)
(2) the machining time (in s) (9 points)

Ch 3: Multiple point cutting

1. Estimate the machining time (4 points) and the average chip thickness (4 points) in the face milling with tool of 80 mm diameter, 6-teeth, 15º lead angle, and 20º face cutting edge angle, at a feed of 0.01 mm/tooth and a spindle speed of 1000 rpm.



2. A peripheral milling operation is to be done with a machine that has 8 kW spindle power. A 6-flute cutter with 30 mm diameter was chosen to machine a 60 mm long carbon steel block with 6 mm radial depth of cut and 50 mm axial depth of cut in an up cutting configuration. Since the depth of cut covers the entire width of the workpiece, the surface of concern is created along the wall of the cutter. Assume that the maximum cutting power is twice the average cutting power. There is no need to use safety factor in your calculation. What is the best surface finish achievable in R_a for 45s cycle time? (in μm) (12 points)

3. Assume that a 20 mm diameter two flute twist drill with the point angle of 140º will be used to make a number of holes in cast iron. Assume that the cutting speed is v = 0.3 m/s and the relative feed is 0.5 mm/rev. Determine the rotational speed N (4 points), and the time to make a hole through 85 mm of material (4 points). Estimate the torque (4 points) and power (4 points) needed to make a hole.

4. How to make the drill with the spiral holes for cutting fluid delivery? The tool material is tungsten carbide in cobalt matrix. (4 points)