Concepts I
Tolerances, Limits, Fits and Surface Finishes

Tuesday 6th Week

Kogan #2 Redo Feedback

- 50% of those eligible redid assignment
  - Those who did not continue to make poor decisions

- All but one person of those attempting assignment again raised their grade to a C – excellent.
Tolerances

(In week 2 we spoke briefly about Tolerances)

- No feature of a component can be perfect (i.e., no surface flat, no hole round etc), because of the manufacturing process
- Thus, when dimensioning any feature
  - Basic nominal dimension
  - Permitted variability (tolerance)
  - Dimensions should be given in as large a tolerances as possible without interfering with the function of the part to reduce production costs.

\[
\begin{align*}
\text{20.15} & \quad \text{20 ± 0.15} & \quad \text{20 + 0.01} \\
19.99 & \quad -0.01 & \quad \text{Unilateral}
\end{align*}
\]

Limits

- Example
  - Journal bearings are designed to operate at high rotational speed
  - If the clearance between the inner and outer diameter is too small the bearing will seize
  - If the clearance is too big the shaft will vibrate
  - Limits on the size of the shaft and hole provide correct operation

\[
\begin{align*}
\text{Nominal diameter} &= 20 \text{mm} \\
\text{Close running fit} &= \text{H8/f7} \\
\text{f7: Shaft} &= 19.980 \text{ to } 19.959 \\
\text{H8: Hole} &= 20.000 \text{ to } 20.033 \\
\text{Clearance} &= 20 \text{ to } 74 \text{ micron} \\
\text{0.00 H8/f7}
\end{align*}
\]
Limits (continued)

Example

- Spool valve has a shaft that translates
- This time the clearance should be a sliding fit

Spool valve has a shaft that translates

This time the clearance should be a sliding fit

Nominal diameter = 20mm

Sliding fit = H7/g6

g6: Shaft = 19.993 to 19.980
H7: Hole = 20.000 to 20.021

Clearance = 7 to 28 micron

Clearance

Ranges in Tolerances

Range of tolerances are a function of:

- Range of measuring tool accuracy
- Range of manufacturing processes
- Range of Limits and fits
- Range of material

As IT # increases so does the range

As nominal size increase so does the range

<table>
<thead>
<tr>
<th>Process</th>
<th>Tolerance range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lapping</td>
<td>IT4 – IT 5</td>
</tr>
<tr>
<td>Reaming</td>
<td>IT6 – IT10</td>
</tr>
<tr>
<td>Drilling</td>
<td>IT10 – IT11</td>
</tr>
<tr>
<td>Casting</td>
<td>IT9-IT11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nominal size range</th>
<th>ISO Tolerances in microns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Over</td>
<td>Up to</td>
</tr>
<tr>
<td>---</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
</tr>
</tbody>
</table>
Fits and Tolerances

- Clearance fit [provide similar running performance with suitable lubrication]
  - Loose running fit
  - Free running fit
  - Close running fit
  - Sliding fit

- Interference fit [create an internal stress that is constant through size ranges]
  - Locational interference
  - Medium drive fit

- Transitional fit [use for location purposes]

[See Figure 5.11 in textbook]

Geometry and Tolerances

- Occasionally geometry itself needs to have tolerances set
  - Flatness = a surface is flat when all elements are in one plane
  - Straightness = a surface is straight if all elements are in a straight line
  - Parallelism = a surface or a line is parallel when all of its points are equal distance from a reference plane
Geometry and Tolerances (continued)

Labeling
- Tolerance box = contains datum label, or information about the tolerance
- Leader line = touches feature or datum and tolerance box
- Datum = some geometries require a reference surface (e.g., parallelism) we label these reference surfaces as a datum

Surface Finish
- Surface texture is the variation in the surface including roughness, waviness, lay and flats.
- Roughness describes the finest irregularities in the surface.

Measures:
- $Ra = \frac{1}{n} \sum |x_i|$
Surface Finish (continued)

Labeling

- $a = 2D$ parameter 1
- $b = 2D$ parameter 2
- $c = 2D$ parameter 3
- $d = $ manufacturing method
- $e = $ lay pattern
- $f = $ allowance
- $x = $ not allowed

Milled

$U \text{ Ra max 3.1}$
$L \text{ Ra 0.9}$